INNOVATIONS IN MULTI-MODAL, SCHEMATIC, TRANSIT MAPPING: AN EXPLORATORY SURVEY

A Thesis
Presented to
The Academic Faculty

by

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In Partial Fulfillment
of the Requirements for the Degree
Master in the
School of Civil and Environmental Engineering
School of City and Regional Planning

Georgia Institute of Technology
May 2013

INNOVATIONS IN MULTI-MODAL, SCHEMATIC, TRANSIT MAPPING: AN EXPLORATORY SURVEY

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and all other map lovers out there,

go find your way!

ACKNOWLEDGEMENTS

This project has been fun, challenging, and a lot of hard work. I could not have completed this thesis without the help, support, and guidance from so many. There are so many people that I need to thank and acknowledge. Without any of them, this thesis would not have been possible.

I must first thank my adviser, Dr. Kari Watkins. It was a pleasure and privilege of mine to work with her for this thesis. Over the last two years, she challenged me to always be my best and set me up for success both in graduate school and beyond. I have learned so much from her about the field of transit planning and engineering durng my years at Georgia Tech.

To my family and Chris for all of the support you have always shown. Your constant love and encouragement are things that I could not do without.

A big thanks goes Josie Kressner, a PhD student who also served as an adviser on this project. She has helped me to see this data from multiple points of view and had given me greater insight into the academic field.

I could not have done this project without support from MARTA. Ryan Van-Sickle in the planning department was instrumental in coordinating with me, supplying required data, and supported this project from the very beginning.

To Amanda Wall and Anne Jacobs who both performed undergraduate research that supported this project.

A huge thanks goes to all of my surveyors: Joel Anders, Aaron Gooze, Chris Maddox, Alex Poznanski, Maria Roell, Amanda Wall, Dr. Kari Watkins, and James Wong

Another huge thanks to everyone who helped me stuff envelopes for the mail-home surveys: Lance Ballard, Candace Brakewood, Aaron Gooze, Josie Kressner, Gregory MacFarlane, Chris Maddox, Aditi Misra, Alex Poznanski, Landon Reed, Maria Roell, Ryan Sager, Sarah Windmiller, James Wong, and Stephanie Zinner

A big thanks to the team that helped to develop the tablet and web versions of the survey: Dr. Randall Guensler, Andreas Nagel, Vetri Elango, and Ramik Sadana.

Thanks again to everyone for their help and support on this thesis.

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SUMMARY

Innovations in Multi-Modal, Schematic, Transit Mapping: An Exploratory Survey is a survey-based research project that examines the effects that multi-modal transit maps could have on transit ridership and overall system understanding. The maps used in this project include transit routes that meet certain destination or frequency criteria, regardless of mode. This thesis details the creation of the maps, the surveys used to test them, and analysis of the results. Graduate students at the Georgia Institute of Technology conducted these surveys from April, 2012 through February, 2013 in Atlanta with the cooperation of the Metropolitan Atlanta Rapid Transit Authority (MARTA).

Schematic maps display a geographic system in an abstract way. Instead of showing every twist and turn of each route, they streamline the map to include only straight lines as well as 90 and 45 degree angles. This makes the maps visually easier for transit riders to follow. Historically, schematic maps have been created with train routes in mind. Bus maps, on the other hand, are a different story. Bus systems can be much larger and further-reaching than train systems and their maps are often displayed geographically. Today's transit systems are increasingly multi-modal and designed for interaction of modes, yet many transit agencies still have separate maps for each mode. Providing a separate map for each mode is increasingly difficult as the lines between modes are blurring with new light rail enhancements as well as the the use of express buses, enhanced buses, and improved frequencies on local buses. Based on the literature as systems continue to integrate modes, there is a need for multi-modal maps to help make these systems easier to navigate.

Multi-modal systems also require multi-modal maps so that riders only need to consult one map to find their way across multiple transit modes within the same system. Multi-modal maps are especially important for choice transit riders so that they are not deterred from taking transit if the information is poor or incomplete.

Using the Atlanta Region and its transit agency, the Metropolitan Atlanta Rapid Transit Authority (MARTA), as a case study, this project tested mode integration in schematic maps through surveys of transit riders and non-riders. MARTA is a good case study for this survey because it has a limited train system and a large (93 routes, 2 shuttles, 2 BRT routes) bus system that is not easy to navigate using the system map. The three main goals of the project were to:

1. Examine reactions to multi-modal, schematic maps and what riders are looking for in system maps.

2. Explore whether adding bus routes to a schematic rail map has the potential to increase bus ridership.

3. Explore how adding bus routes to a schematic rail map affects understanding of an overall transit system.

To accomplish these goals, a survey was developed that addresses these very issues. The key questions that are analyzed in this thesis ask whether bus routes with frequent service or that reach popular destinations are more important and whether these maps would influence future bus ridership and overall understanding of the MARTA system.

Using the MARTA train map, multiple new maps were created, each one adding bus routes that met certain frequency and/or destination criteria. This included a map with train lines and all bus routes that connect to a MARTA park and ride lot, a map of routes that connect to popular destinations, and a map that includes all bus routes that have at least 20-minute headways.

These new maps were tested against the existing train-only map in two separate surveys. The first survey was conducted in-person on board MARTA trains. The purpose of the on-board survey was to capture both train and bus riders as well as train-only riders. These riders have seen the schematic MARTA train map at least once because they have ridden the MARTA train at least once.

The second survey was a mail-home survey conducted in four neighborhoods selected based on proximity to bus routes included in the new maps. The purpose of the mail-home survey was to receive opinions and responses from bus-only and non-transit riders in addition to train-riders. It was important to conduct these two surveys to reach both captive and choice riders as well as participants who ride transit, only the train, and who currently do not ride transit.

Based on these surveys, these multi-modal maps were found to be particularly effective for improving passenger understanding of transit service, small ridership increases, and have the opportunity to improve perception of transit service and an agency.

There were three main findings in this thesis. The first was the importance of not only map design, but route and network design. As seen through survey results, the majority of participants stated that bus frequency was the most important attribute, yey riders ranked the popular destinations map as the most useful. In this survey, it was clear that there was a disconnect between where the service was and where people wanted to be able to go. This disconnect is not necessarily a mapping issue but a network planning issue that should be addressed by the transit agencies.

Another important finding was the potential to increase bus ridership. Based on the survey conducted for this thesis, 43% of participants stated that they would ride the bus more in the future if these multi-modal maps replaced the current MARTA train map. While the more often participants currently ride transit, the more often they responded that they would ride the bus more, this was not always the case.

Of participants who currently do not ride the bus at all, 34.4% and 9.4% from the on-board and mail-home surveys respectively said they would ride the bus more. It is important to note that this is a stated preference question and that it is likely that not all of these people will change their habits [12], but these numbers do indicate the potential to increase bus ridership by implementing these multi-modal maps. This increase could be due to the fact that participants now realized the frequency of these bus routes, or the fact that they now know that they can get to more places using transit.

As earlier discussed, many systems have multiple maps to describe rail and bus service which can give the impression that they are separate systems. After viewing these multi-modal maps, the majority of participants stated that their understanding of the overall system would improve. In these surveys, 61% in the on-board survey and 63% in the mail-home survey stated that the maps would help with understanding the overall MARTA system better. People who are more confident reading transit information materials may be more likely to consider taking transit as a transportation option instead of ruling it out completely. Providing both riders and potential riders with maps that are easier to understand would help them orient themselves better in the system and be more open to taking transit in the future.

Based on the literature and results from this survey, there are a few important pieces of information that transit agencies should consider when creating these maps. This includes frequency, destinations, service, service standards, include street names, and clearly identify the modes. Additionally, agencies should create different maps for different groups of riders, such as regular users and tourists, one being more frequency-based and one being more destination-based. However, it is important to still include landmarks and locations within the frequent map to inform regular train riders that there are more places that they can reach using transit.

The findings from this research are important because transit systems are changing. They are becoming more multi-modal to provide better connectivity. As found in these surveys, even with the availability of smartphones and online information, 15% of participants still use paper maps to plan train trips and 29% use them to plan their bus trips. For these riders, as well as those who use the maps for guidance along the way, multi-modal maps should effectively display transit information regardless of mode.

CHAPTER I

INTRODUCTION

Innovations in Multi-Modal, Schematic, Transit Mapping: An Exploratory Survey is a survey-based research project that examines the effects that multi-modal transit maps could have on transit ridership and overall transit system understanding. The maps used in this project include transit routes that meet certain destination or frequency criteria, regardless of mode. It is important to note that this thesis focuses on paper and printed maps, rather than trip planners and websites accessible online with a computer or smartphone. This thesis details the creation of the maps, the surveys used to test them, and analysis of the results. These surveys were conducted by the Georgia Institute of Technology from April, 2012 through February, 2013 in Atlanta with the cooperation of the Metropolitan Atlanta Rapid Transit Authority (MARTA).

1.1 Purpose and Need

Schematic transit maps have been part of the transportation industry for over a century. Because trains are not constrained to the street network, their routes can be simplified with the use of straight lines and simple angles. Schematic maps have essentially made cities easier to navigate via transit and in some cities, such as London, they have even become an icon.

Historically, these schematic maps have been created with only train routes in mind. Bus maps, on the other hand, are a different story. Bus systems can be much larger and further-reaching than train systems and their maps are often displayed geographically. It can be more difficult to schematically simplify all of the routes together without distorting them too much. Additionally, bus maps tend to

be constrained to the street grid, unlike subways or elevated rail systems. Rail often follows a structured path under or over the street netowrk. These geographic maps with routes that overlap and are in close proximity can be confusing and overwhelming to transit riders and non-riders.

The historic map separation by mode worked when there were a limited number of modes and their systems operated separately. Today's transit systems are increasingly multi-modal and designed for interaction of modes, yet many transit agencies still have separate maps for each mode. This is increasingly difficult as the lines between modes are blurring with new light rail enhancements as well as the the use of express buses, enhanced buses, and improved frequencies on local buses. Enhanced buses are local bus routes that employs some type of technology to improve its time and reliability, including but not limited to transit signal priority, multi-door boarding and/or queue jumpers. As these systems integrate modes, so must the overall maps so that these systems are easily navigable. This historic separation of bus and train maps can make it difficult to find transfer locations between modes and can make the entire reach of the system unclear. Addressing this disconnect between modes becomes especially important in cities where the train system is limited and a bus transfer is required to reach many locations.

For cities without established, comprehensive train systems, the cost and potential time of construction for new infrastructure can be extremely high, yet the demand for public transportation remains. To address the gap between transit demand and cost, cities today are more frequently considering alternative modes such as light rail, bus rapid transit (BRT), express buses, streetcars, and increasing frequency for local buses. Based on the literature as systems continue to integrate modes, there is a need for multi-modal maps to help make these systems easier to navigate.

Comprehensive maps are especially important for choice transit riders. All transit riders fall into one of two groups, choice riders or captive riders. A choice

rider decides to take transit because they perceive that the mode is a superior choice because of monetary and/or time costs as well as convenience and attributes that vary rider to rider including cleanliness and service reliability. A captive rider must take transit because he/she has no access to any other viable forms of transportation [1]. While printed materials have been shown not to be a significant barrier to transit use, there are some riders who indicate that more confidence in understanding maps would encourage them to ride transit more [3]. Keeping these choice riders and providing maps that are easily understood is important to contributing to their decision to ride.

Using the Atlanta Region and its transit agency, the Metropolitan Atlanta Rapid Transit Authority (MARTA), as a case study, this project tested mode integration in schematic maps through surveys of transit riders and non-riders. Atlanta is an example of a city with both a limited train system and expansive bus system, as seen in Figure 1. While the rail map shows four train lines, the two north-south often overlap as do the east-west lines. However, there are 93 bus routes, two shuttles, and two peak hour BRT routes that fill in the large gaps left by the train system. Additionally, the transit in this city is also expanding to include other modes. There is an existing BRT (queue-jumper) route, a streetcar line under construction, and a light rail line in the environmental and planning phases. Multi-modal map research is important in Atlanta because of the planned addition of new transit modes that will be operated by different entities. This thesis recommends how to integrate these systems into one multi-modal map. By having one map, bus information will be easier to understand.

This project tested two types of multi-modal, schematic maps; ones that are based on frequency and others on destination. In the transit mapping industry, there have been calls for frequency-based transit maps through blogs and social media, but little push for destination-based ones. One of the main purposes of this project is to determine which of these map types is more important to transit riders when they are

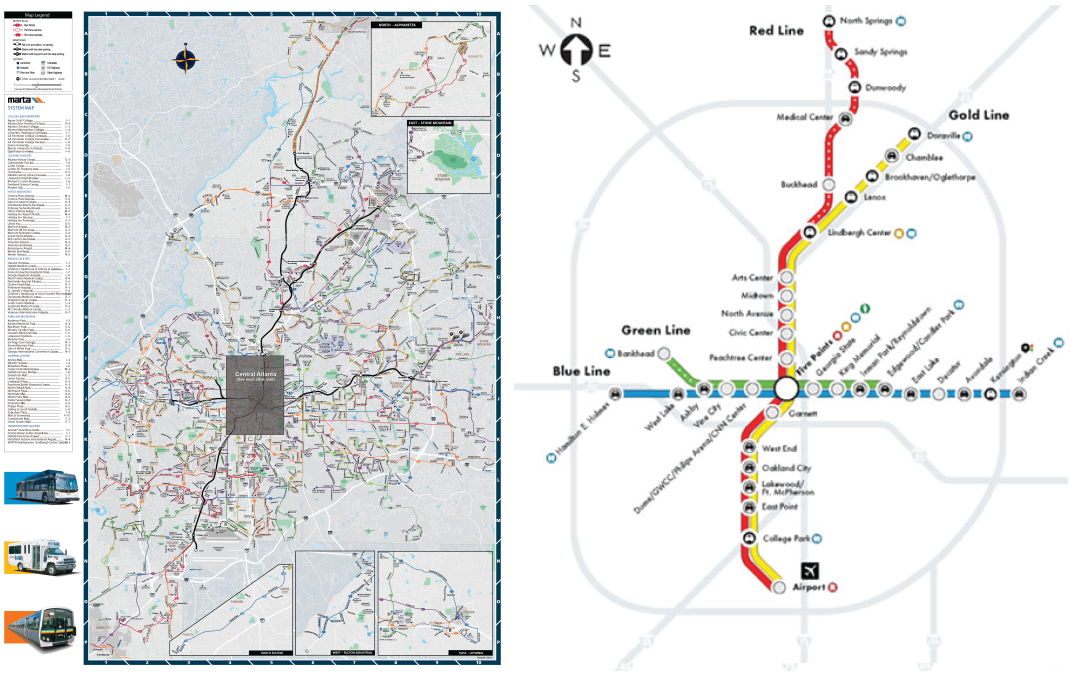


Figure 1: Current MARTA Bus System (left) and Train System Maps (right)
Source: MARTA, 2012

considering whether or not to ride these alternative modes. In one map, trains, BRT, and buses will be included to show how they can work together to provide access to more places throughout the city of Atlanta than the train can alone.

1.2 Project Goals

The project uses two surveys to determine the potential impact that multi-modal, schematic maps could have on transit rider mode choice and system understanding. The three main goals of the project are to:

1. Examine reactions to multi-modal, schematic maps and what riders are looking for in system maps.

2. Explore whether adding bus routes to a schematic rail map has the potential to increase bus ridership.

3. Explore how adding bus routes to a schematic rail map affects understanding of an overall transit system.

Finally, the conclusions will include a list of important things for transit agencies to consider when creating these multi-modal maps.

To create the test maps, other cities with innovative maps were consulted and researched. This included cities with select bus routes on their train system maps and cities that have created destination- or frequency-based maps. This project looks to get the users perspective and opinion on these maps and their potential impact.

The purpose of administering two different surveys is to receive responses from the following groups of transit riders:

- Train-only riders
- Train and bus riders
- Bus-only riders
- Non-riders

While research has been done and surveys have been performed on the effect maps have on the wayfinding and travel decisions of riders, nowhere in the review of previous literature was there a survey to directly address these multi-modal maps and understand what riders and potential riders want to see on the maps and how they could affect ridership. This project looks to fill that gap.

The results of this project will demonstrate the potential impact that these maps could have on ridership as well as general understanding of transit systems by riders. While mobile applications and directions are increasingly popular, paper and station maps are still important to many riders to help find their way and guide them along their trip, as a study performed in 2004 found that printed materials were the most popular form of trip planning [4]. While this has probably changed with the

increase in smartphone usage and applications, it is still important to consider printed material. These results will be used to produce a methodology for transit agencies to use when creating multi-modal, schematic maps.

1.3 Previous Work and Inspiration

This thesis was inspired by a class project completed by Josie Kressner, Ana Eisenmen, and Stephanie Box at the Georgia Institute of Technology. In their project, they selected certain MARTA bus routes that their research showed should be considered as BRT routes in the future. They then added these potential BRT routes to the map to show how much more coverage there would be than just that of the train system.

In Atlanta, the train system is limited, but the bus system covers the majority of Fulton and DeKalb Counties. The goal of the class project completed by Kressner, Eisenman, and Box was to enhance the schematic train map by adding key bus routes with potential for enhancements. This would not only provide transit riders with more options on the main map that is seen throughout the transit system, but also enhance the perception of the overall MARTA system coverage. The Kressner, Eisenmen, Box team created the map in Figure 2. Their map includes train lines, and MARTA bus routes that they recommended to be converted to BRT routes. Together, these enhance coverage of the system on the common schematic MARTA map.

In summary, BRT is closer to rail, which is why they added it to the rail map. However, included in the goals of this thesis was to create multi-modal maps of the current service provided by MARTA. Instead of adding route and corridors that could be considered for BRT, this thesis added local bus routes within the MARTA system which currently meet certain criteria to show riders and potential riders the coverage that already exists in the system.

The Kressner, Eisenman, Box class project was originally inspired by two papers about schematic maps and their effects on rider spatial understanding. The first,

Figure 2: Proposed BRT Routes by Kressner, Box, Eisenmen Project [2]

Mind the Map by Zhan Guo, discusses the impact that transit maps have on the route choice of riders. His paper discusses how transit riders use perceived distances from schematic maps to make route decisions even though the distances can be skewed and their distances may be misrepresented. The second inspirational paper was by Janet Vertesi and is entitled *Mind the Gap: The London Underground Map and Users Representations of Urban Space* in which she discusses the impact that transit maps have on the perception of a city by riders. Vertesi asked people in London to draw a map of the city and more often than not, they drew key train lines to orient their hand-drawn maps. Both of these papers demonstrate the impact that transit maps have on mode and route choices, as well as how they view their city.

Before creating new maps and surveys to test, an extensive literature review was performed. Included in the literature review are examples of cities with innovative transit maps within the United States. These include, but are not limited to, Chicago and Boston. Boston, has created a schematic map that includes train lines and bus routes based on frequency. Chicago, has created a map with attractions and popular destinations in mind by showing only bus routes that reach these destinations even though they have larger headways. Other cities include Seattle, Saint Louis, Cincinnati, and Portland.

Additionally, to be able to create bus maps that are less busy and highlight certain routes, professionals in the transit mapping field have called for high frequency bus maps. These maps show only bus routes with a specified headway whether displayed geographically or schematically. Showing only select routes reduces the number of bus routes on a map, is easier to read and understand, and makes the bus routes more attractive because they come more often. By mapping according to high frequencies, riders no longer need to consult a schedule because they know they will not be waiting more than a specified amount of time, much like they do for trains. Showing routes with smaller average wait times is especially important for appealing

more to choice riders and making it easier for them to find their way using transit.

This project not only maps current MARTA bus service in a new way, but also tests these new maps on non-riders, train-only riders, as well as current transit riders to see how it could affect their bus ridership and/or enhance their understanding of the existing overall MARTA system.

1.4 Thesis Organization

This thesis includes a comprehensive literature review, project and survey methodologies, results and discussion, as well as conclusions about these maps.

Chapters two and three discuss the background of transit mapping and the project survey methodology respectively. To gather as many responses as possible, multiple surveys methods were used and they are both described in detail. The design and reasoning behind these surveys is discussed in future chapters.

The analysis will include multiple chapters. Chapter five is a description of the data and any bias that may be present in the sample. Chapter six then describes all of the responses to both or the surveys. Based on the responses to all survey questions, chapters seven, eight, and nine will each address one of the following "key" questions asked in the survey:

- *"Is it more important for maps to include bus and train routes that reach popular destinations or that come more often?"*
- *"If one of these maps replaced the current MARTA overall map would you ride the bus more?"*
- *"If one of these maps replaced the current MARTA overall map, would it help your understanding of the overall MARTA system?"*

In each of these chapters, analysis is performed and compared for the two surveys separately and overall results are summarized.

Based on the results and discussion, conclusions will be made about these maps and their effects on the system understanding and potential ridership impacts. Additionally, the conclusion includes further recommendations for expanding research as well as a guide for transit agencies when creating these maps.

CHAPTER II

INNOVATIVE TRANSIT MAPPING BACKGROUND

Since the creation of the schematic London Underground Map by Henry Charles Beck in 1931, train system maps have been simplified with straight lines and simple angles. These simplified routes make it visually easier for riders to follow routes and convey the origin and destination information that riders need instead of focusing on the exact path followed to get there. This is more easily done for train systems than bus systems because train systems do not follow the street network and there are fewer locations to board or alight.

Bus routes on the other hand, are constrained to the road network. Here, riders who are also drivers, know the exact route, as opposed to trains where sometimes riders do not know the route because train lines can be elevated or underground. Riders may only know the station locations. Simplifying bus routes is more difficult because riders are familiar with the streets and local bus routes are accessible at almost every block instead of specified stations. Because of the difference in right-of-way and accessibility, bus maps and train maps are often separated. However, in many transit systems, all transit modes work together to provide the frequency and coverage of the entire system and it may be difficult to fully understand the system and identify mode transfer locations without combined maps.

With so many transit systems becoming multi-modal, some agencies have started creating multi-modal maps and maps directed at certain riders, whether they are tourists or commuters. As cities implement different technologies to improve various transit routes, maps need to convey the information about origin, destination, and

frequency without discriminating by mode. This chapter will discuss (1) the potential effects that transit maps have on transportation decisions, (2) define types of multi-modal maps, and (3) discuss cities who have implemented innovative transit maps.

2.1 Transit Map Effects on Riders

Schematic transit maps effectively simplify a transit system; however they can also skew distances between stations or indicate faster travel times than the service provides. Sometimes two stations look close enough to walk between but in reality are much farther, or vice versa. To aid in these skewed perceptions, some maps add landmarks to act as a frame of reference, such as a water body or popular destination. When creating and analyzing schematic maps, it is important to keep in mind the balance between the true geography and simplified version so that individuals can better gauge distances.

As mentioned in Section 1.3, there are two main papers that discuss how transit maps can affect rider understanding of the area and route choice. In his paper *Mind the Map*, Zhang Guo discusses how schematic maps can affect traveler route choice within a transit system [9]. These distances become skewed because all of the transit lines in the schematic maps are straight lines that are either vertical, horizontal, or at a 45 degree angle. Additionally, station locations are sometimes moved to accommodate station labels, further skewing distances. His main finding was that riders on the Tube relied more on the schematic map to select what they thought was the quickest route than on their actual experienced travel times [9].

In her paper, Jane Vertesi portrays the Tube Map as an "interface between the city and its user." The Tube Map is said to exceed the confines of the transit system itself, overlapping as an icon for tourists and locals alike, indicating that at some times, even regular riders are 'tourists' when they go to new places using the transit

system. In London, an estimated 95% of Londoners have a copy at their residence. This study conducted in London in 2004 involved interviews with transportation professionals, asking for directions to places throughout London, and extended interviews with a variety of London residents. The paper found that "the Tube Map clearly influenced representations of the city of London, both imaginistic and narrative, enabled interventions or interactions with the city (both above and below-ground), and provided a way to distinguish normalcy from distortion, user expertise from resistance" [17]. The definition of what constitutes London comes from the structural elements of its famous map. The study shows that, with subway maps, there should be some correlations between representation, intervention, and resistance in regards to travel time and cost. While schematic maps are sleek, they can sometimes skew distances between station locations and may make two locations appear to be either closer or further than they actually are [17]. This is especially important when creating schematic bus maps because bus stops tend to be much closer together than train stations.

Transit riders are also often drivers and know the street grid well if they are residents of the city in which they are riding transit. As shown in these studies by Guo and Vertesi, schematic transit mapping skews perception of distance because these riders do not have another frame of reference. With bus systems, the street network is another frame of reference to compare to, which can affect understanding or trust of a schematic map of streets that are not actually straight. Addressing thee issue of nonlinear streets is particularly important in Atlanta where the city is only gridded in limited areas. To provide another frame of reference, the city highways (I-20, I-75, I-85, I-285, GA 400) were added. Most cities, such as Boston, Chicago, New York, and others, have added bodies of water to provide orientation and guidance, but there is not a significant body of water within the limits of the MARTA train system.

The Atlanta bus system (Figure 3) is not only confusing when all routes are

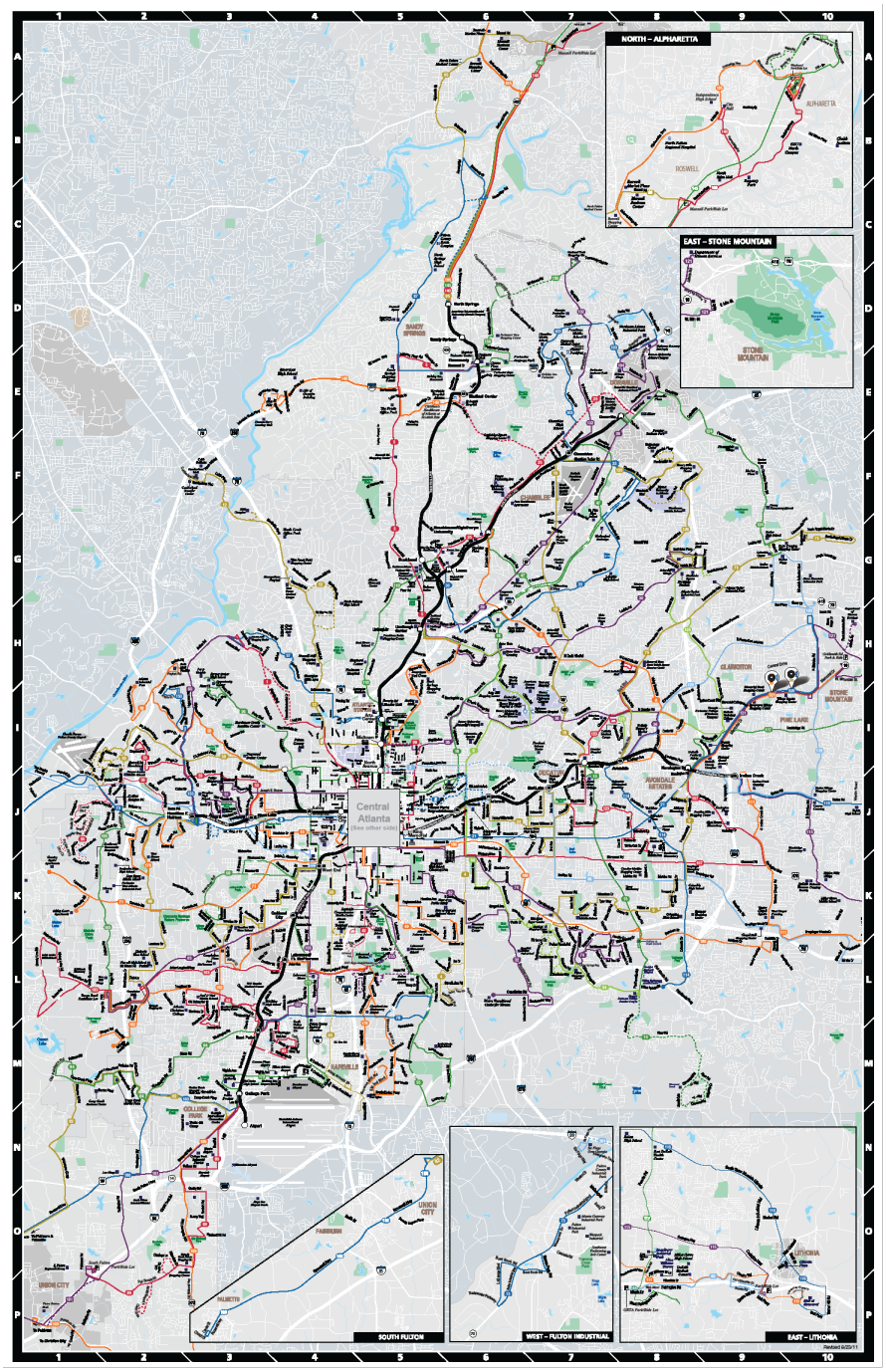


Figure 3: MARTA Bus and Train System Map
Source: MARTA, 2012

shown at once as equals with six colors representing 93 routes, but is also not publicized as much as the train system. At train stations, individual schematic (Figure 4) route maps are readily available and the train system map is prevalent, but the bus system map is not shown as often. Within all of the MARTA rail stations, the rail-only map is displayed 154 times in and around stations while the bus system map is displayed 80 times [5] in and around stations and not at all on the train. Additionally, this system map does not show connections to other surrounding transit agencies. While this may limit some riders who need to connect beyond Fulton and DeKalb counties, this it outside the scope of this project.

In addition to affecting route choices, the ability to understand maps may affect the confidence of transit riders. Alasdair Cain did substantial work at the University of South Florida in map design where he conducted a study entitled *Are Printed Transit Information Materials a Significant Barrier to Transit Use?* Here, survey participants were asked to perform various wayfinding tasks. From this survey, 18% of participants said that after this experience, their transit use would increase. While one of the main conclusions was that transit information materials are not a significant barrier to transit usage, the survey indicated was that there may be a correlation between how easy participants thought the tasks were and whether they stated they would use transit more in the future [3]. While this was not the reason that non-riders said they do not ride the bus (70% said it was because they have access to a vehicle[3]), it is important to reach this portion of the population that might ride transit with better information.

These results are important to this project because while printed transit materials do not directly dissuade potential transit riders, the easier they are to understand, the more confident a person is and more likely to consider taking transit to their destination. If Atlanta's map could be more informative and easy to understand, more people may consider transit as an option.

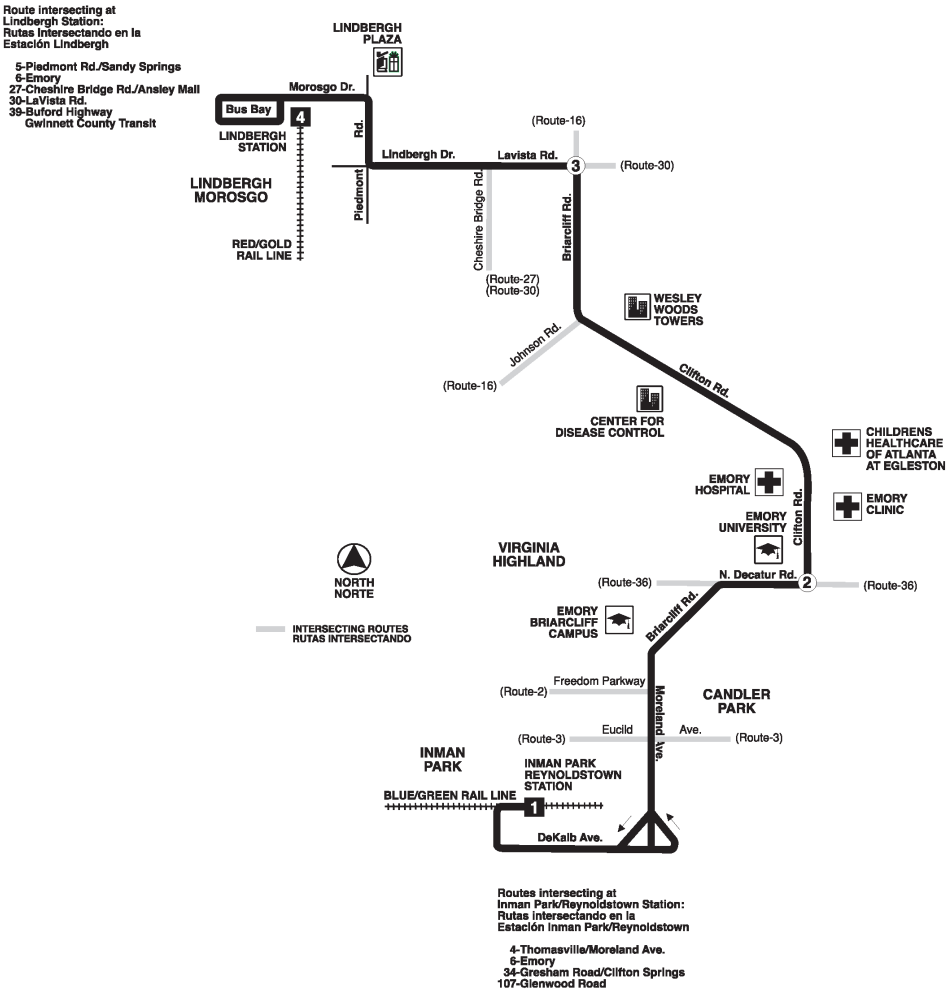


Figure 4: MARTA Bus Route 6: Emory Schematic Street Map
Source: MARTA, 2012

Based on these sources, schematic maps can be helpful but should be designed in a way that reduces skewed distances and presents information in a way that is easy to understand for riders.

2.2 Types of Multi-Modal Maps

Frequency bus maps are maps that highlight bus routes that come frequently, typically defined as less than ten minutes. When transit comes at least every ten minutes, riders do not have to plan around a schedule; they can simply show up at the station when it is convenient for them and know they do not have to wait very long. There are multiple ways that bus systems highlight their frequent bus routes:

- A frequency map can be a separate map of all routes, or route segments, that are frequent either all day or during defined peak hours (Figure 5)
- A frequency map can show all of the bus routes in the system and highlight the frequent ones through colors (Figure 6)
- A frequency map can show all of the bus routes in the system and highlight the frequent ones through line thickness(Figure 7)

As mentioned in the introduction, transit mappers and advocates have been calling for frequent transit maps. Some of the more prominent transportation blogs, such as *Greater Greater Washington* and *Human Transit* have discussed the importance that frequency and headway knowledge play in trip planning and how riders perceive travel and wait time.

One important distinction is the difference between frequency and headway. Frequency is how many times per hour a bus runs and headway is the amount of time in between each run of a single bus route. To make it easier to riders to understand, it is often the headway that is displayed, such as "this bus will run every fifteen

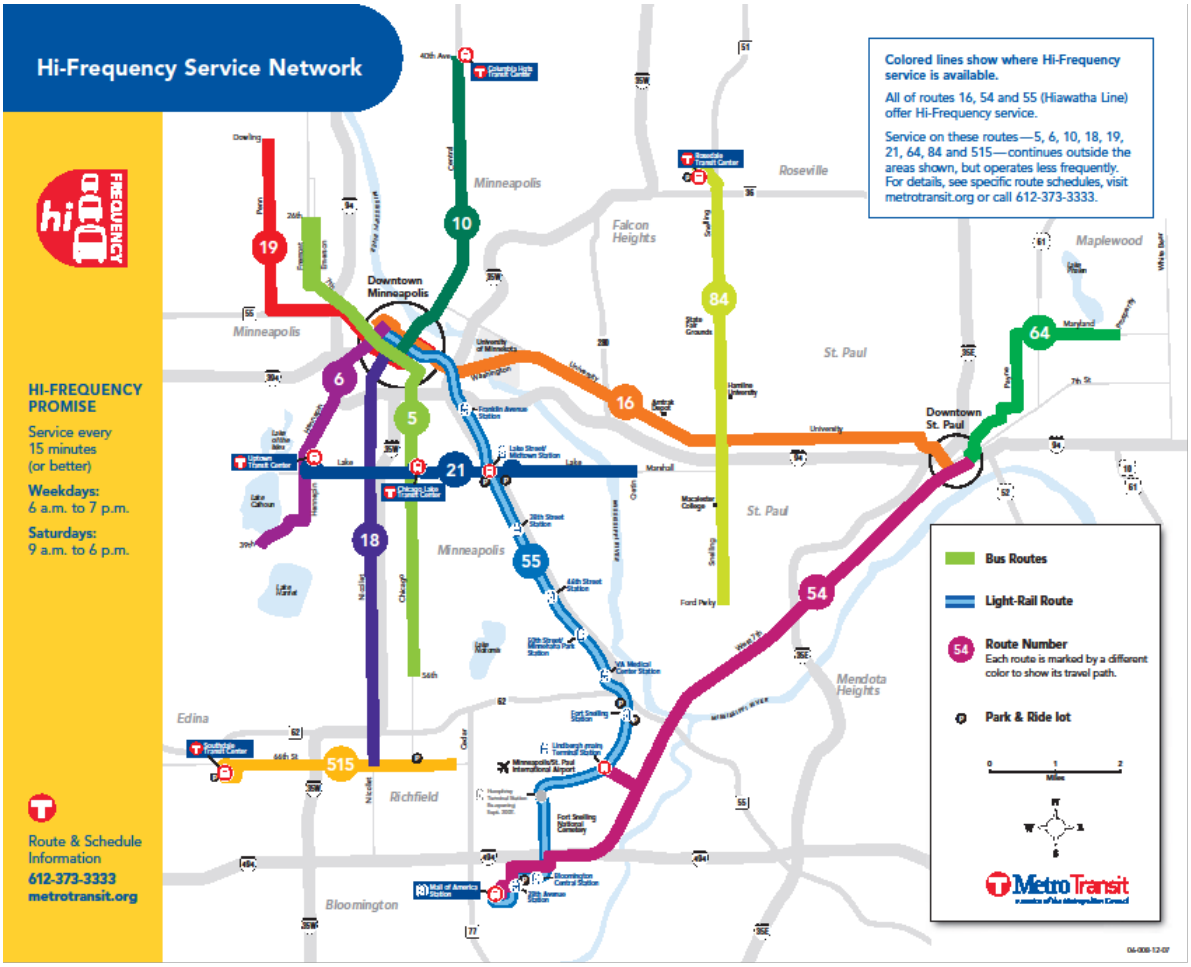


Figure 5: Minneapolis Metro Transit Frequent Bus Service Map
Source: Metro Transit, 2012

minutes", however these maps are called frequency maps to indicate that these buses come often.

In addition to bloggers calling for frequent transit maps, a study out of the University of Florida conducted a web survey which found that when headway information was included on maps, riders tended to state that the maps conveyed information more effectively. It also found that including headway information was important for users that needed to transfer at least once because better headways meant they did not have to worry as much about waiting time at the transfer location [10].

Figure 6: Seattle King County Metro Frequent Bus Service Map
Source: King County Metro, 2012

2.3 Innovative Transit Maps in the United States

In response to these calls for frequency maps and the surveys that support their effectiveness, some transit agencies within the United States have started creating more innovative, multi-modal transit maps. One article that summarized effective transit map redesigns was *Routing Culture: Mapping the Culture of Transit Systems* by Tim Newcomb. In his article, he discussed certain transit maps that have been redesigned since the 1990's, including New York, Washington D.C., Boston, Chicago, and San Fransisco. All of these maps were redesigned with the transit users in mind

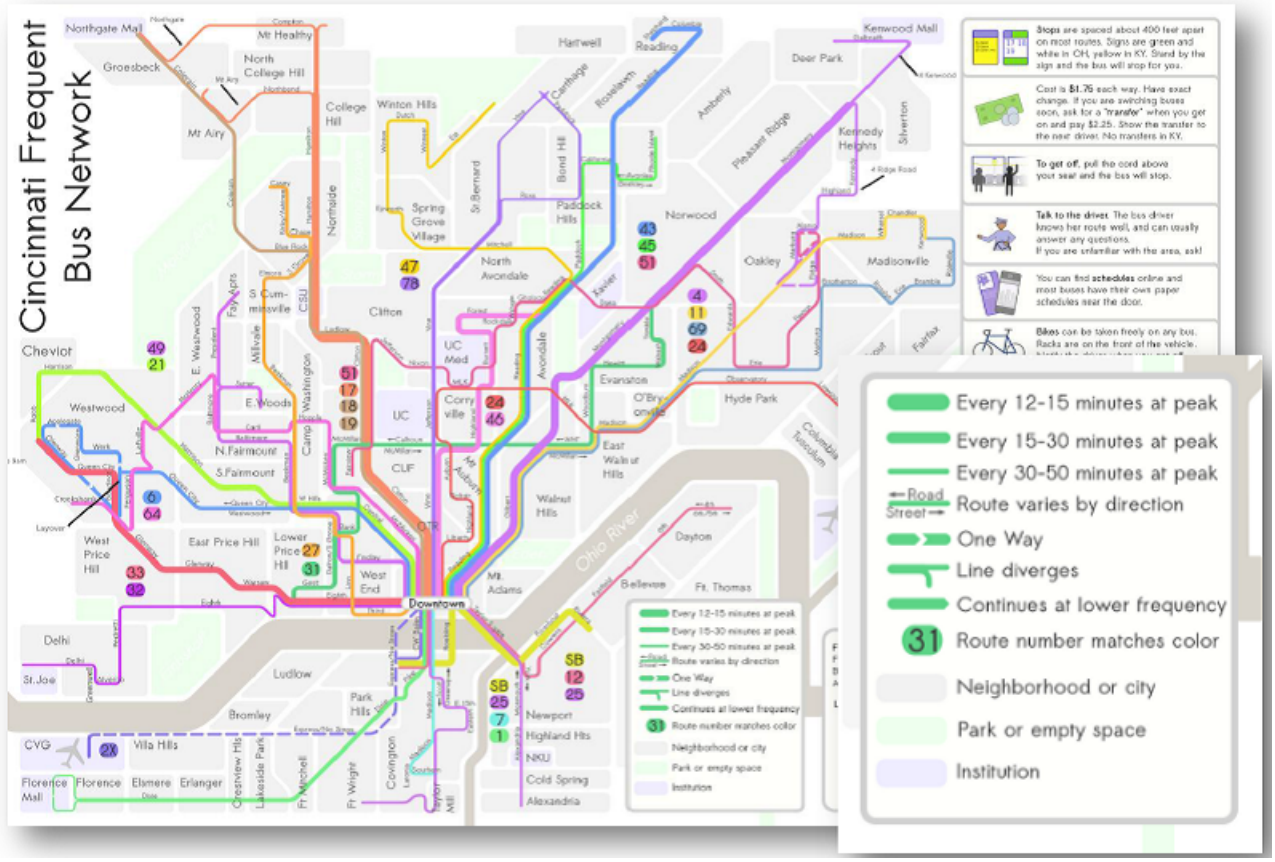


Figure 7: Cincinnati Metro Frequent Bus Service Map
Source: Metro, 2012

and to more effectively convey transit information. Important highlights throughout the cities was the importance of reference points, whether it is green for parks, blue for water bodies, and the schematic vs. geographic discussion. Another important example of innovative map design came from Lance Wyman, who was the first person to include the historic monuments on the Washington D.C. metro map and demonstrate the importance of landmarks for orientation in schematic maps, especially for tourists [14].

Additionally, the Washington Metropolitan Area Transit Authority (WMATA) map was recently redesigned again because of the future addition of the Silver Line, a new transit line that will eventually connect to the Dulles International Airport. The

Figure 8: Washington D.C. WMATA Map with Historic Monuments
Source: WMATA, 2012

blog *Greater Greater Washington* hosted a design competition where anyone could submit their own redesign of the WMATA transit map. The man behind this blog and the competition was Matt Johnson. He discussed the success of this exercise. The contest had 17 entries that were judged in two parts; the people's choice and a jury of various transportation professionals and media. While this competition was not associated with WMATA, multiple changes were made that were recommended by these map entries, such as renaming certain stations and adding an icon to indicate parking at stations where available [11].

The Massachusetts Bay Transportation Authority (MBTA) has a map that includes commuter rail, subway, and "key" bus routes, as seen in Figure 9. These "key" bus routes all meet three criteria: (1) bus routes must run seven days per week,

(2) bus routes must have a headway of fifteen minutes or less during peak hours (7-9am, 5-7pm) on weekdays, and (3) bus routes must start and end at a rail station or bus depot. The current map using these criteria was designed by Ken Dumas in the 1990s. Dumas made dramatic changes by redesigning the subway lines to better represent distance and adding water bodies as reference points [7]. The buses were then added a few years later. An interesting note, previously, Interstate 90 and Route 128 were included in the map to help orient riders, but were removed when the buses were added. The MBTA has gone away from using highways to orient riders and more towards transit corridors and georgaphic landmarks. However, in Atlanta, the only references are the highways.

According to Erik Scheier, the MBTA Project Director for Operations, the goal of adding the bus routes was to improve peak bus service on routes with high ridership and provide clear transit access to neighborhoods that were unreachable by subways and commuter rail. According to Scheier, there was a small increase in ridership on these routes, but these were already the busiest routes and it was not possible to tell if it was due to the addition of bus routes to the map. Another reason for adding these bus routes was to prioritize them and improve the level of service (LOS) they provided. By adding them to the map, the MBTA worked to better ensure that these routes were held to their schedule since they were included in the "rapid transit map" [16].

The Chicago Transit Authority (CTA) in Chicago has created an attractions map that is aimed at tourists and newcomers to the city, as seen in Figure 10. This includes bus routes that reach popular tourist attractions, even though they are not the most frequent. In an interview with Graham Garfield, the CTA General Manager of Customer Information, some version of the CTA attractions map has been around since the 1970s. The current one has been in place for approximately ten years and is updated annually. With regards to the criteria of landmarks that are included on the

Figure 9: Boston MBTA System Map
Source: MBTA, 2012

map, Graham said that it can be more subjective than objective about where people want to go. They looked at locations that draw large amounts of visitors and that have high capacity, especially places that people from out of town want to visit. Also included on this map are numerous hotels. To be included in the list of hotels on this map, hotels must have a minimum size and room requirement [8]. Additionally, CTA has a night-owl map that highlights bus routes that run through the night, demonstrating how effective it can be to have multiple maps for riders with different trip purposes and travel times.

Figure 10: Chicago CTA Tourist Attractions Map
Source: CTA, 2012

There has been a lot of emphasis on creating frequency maps, but fewer transit agencies have looked to implement maps that are oriented around popular destinations and/or tourist attractions. One of the purposes of this project is to survey riders about what they would rather see on the maps to make recommendations to MARTA how, if at all, select bus routes should be added to the existing rail map.

There are transit agencies creating innovative maps that display multiple modes in a schematic way and are good examples that Atlanta can follow. However, there is no documented guide of how to integrate multiple modes, nor have transit riders been asked their opinions on these types of maps. This project looks to here fill that void.

CHAPTER III

PROJECT METHODOLOGY

After reviewing the literature and interviewing transit map designers, the plan detailed in this chapter was developed. This chapter details (1) the map design process, (2) the creation and administration of all survey methods used, as well as the analysis plans for the (3) survey samples, and (4) responses to the key research questions.

3.1 Map Creation

3.1.1 Overall Map Design

The maps used in the surveys and final product were created using Adobe Illustrator. Design included considerations from the interviews and literature review as well as destination analysis. It was important to make new maps that were functional but also visually pleasing. The maps were kept schematic so that the rail lines on the maps would look exactly the same as they do now. Additionally, in an interview with Dennis McClendon, a former CTA map designer, he emphasized the importance of using schematic maps for public transit based on his experience interacting with transit agencies and riders [13]. McClendon also recommended providing headways and the time of service if the displayed headways are not continuous.

The CTA performed a survey about information to include in transit maps. This included a survey of transit riders as well as transportation professionals. In these surveys, the main finding from the survey of professionals was that maps need to be clearer, while retaining the high level of information. The customers stated that trip planning is primarily done in advance and maps in stations are needed to guide travelers along the way. Additionally, the CTA found that information should be clearly stated once, rather than stated in multiple ways [15].

When creating these maps, the importance of color, line thickness, and route labels were identified in a literature search prior to the design of the maps. Additionally, in the same guide created by Alasdair Cain recommended including landmarks and streets to help orient transit riders [4]. In the maps created for this survey, attractions were incorporated and their selectio is detailed in Section 3.1.2.2. On routes that provide service along a consistent corridor, the street was identified.

There were standards used across the board so that the questions regarding this map could focus on the key research questions and not as much on visual inconsistencies. Some characteristics that were kept consistent in all of the maps include the following:

- MARTA rail line colors
- MARTA rail station symbols
- Orange was used for the Memorial Drive BRT route
- Square symbols for bus stops/destinations
- Purple bus lines when there were more than six bus routes

One issue with including bus routes on this map is that some bus routes have service that alternates between multiple variations of the same route. The segments that did not conform to the criteria were left out and indicated with an arrow. The maps were supposed to be as intuitive as possible, so there was no key/legend included on the map. Only two of the on-board survey participants complained about the lack of a legend and no one noted confusion.

3.1.2 Individual Map Criteria

Once the visuals were generally set, five maps were created with various criteria for bus routes to be included. The criteria for each map refers to the requirements that

bus routes needed to meet to be included. The five maps created by the project team were:

- *Park and Ride Map:* This map is focused on park and ride lots and bus routes that could serve as feeders into the train system (Figure 11).
- *Popular Destinations Map:* This map is focused on including bus routes that reached popular destinations including attractions, shopping locations, and employment centers (Figure 12).
- *15 Minute Frequency Map:* This map is focused on frequency throughout the bus system (Figure 13).
- *15 Minute Peak Frequency Map:* This map is focused on frequency during peak commuting hours, as designated by MARTA, when many trips are taken in the transit system (Figure 14).
- *20 Minute Frequency Map:* This map broadens the bus routes included in a frequency map to those that run at least every 20 minutes (Figure 15).

3.1.2.1 Park and Ride Map

This map includes all bus routes that connect the train system to MARTA-owned Park and Ride Lots. The goal of this map was to demonstrate how these routes could be used as feeders to the train system for those commuting longer distancts, such as outside of I-285. There were no frequency criteria for this map. This could potentially demonstrate a larger feeder system if other park and ride lots are included. In this map there were only five routes and they were symbolized as purple, hollow lines with the same thickness as the rail lines.

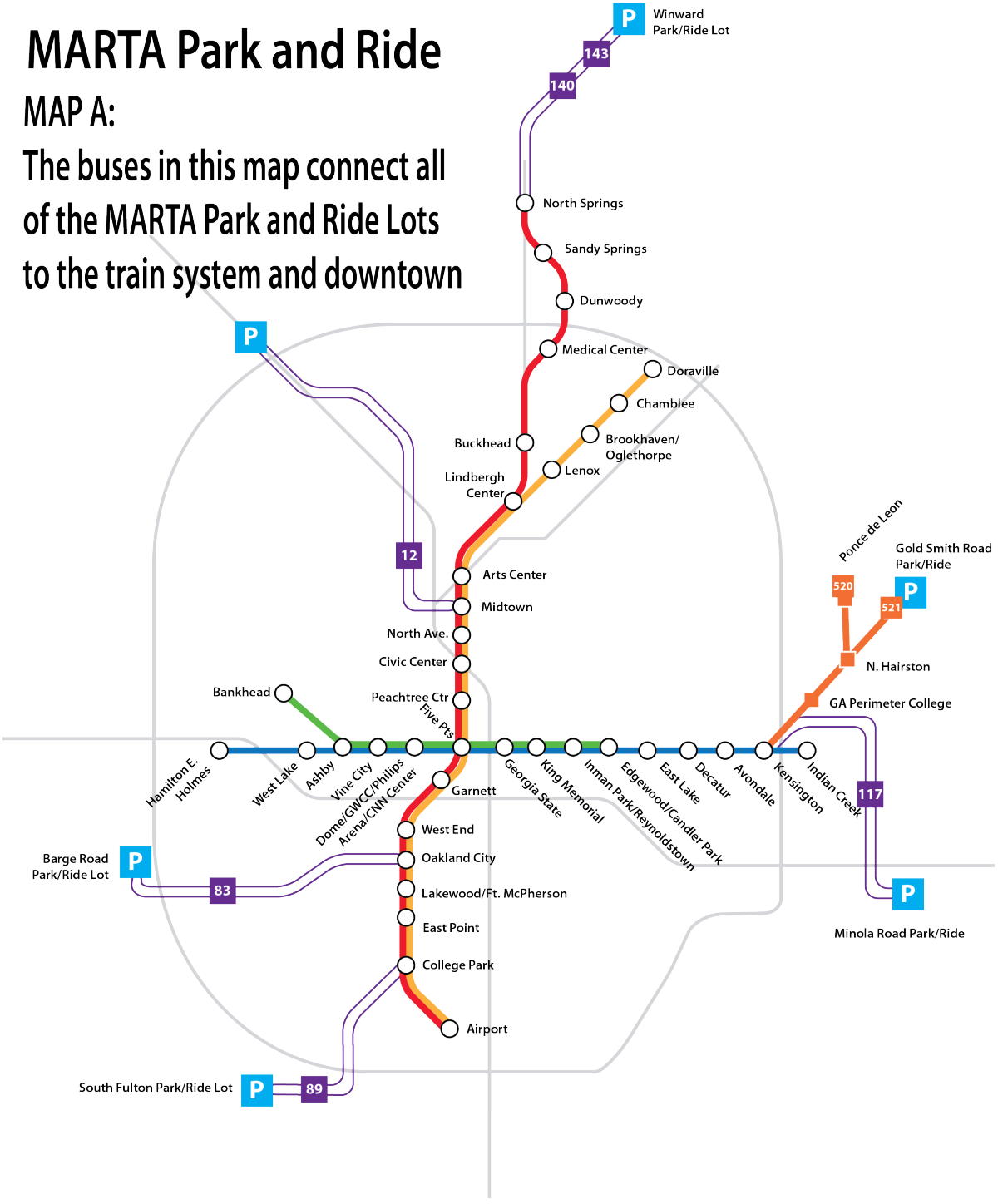


Figure 11: Park and Ride Map

3.1.2.2 Popular Destinations Map

All of the bus routes on this map have headways of at least 30 minutes all day and provide access to multiple of the designated attractions. It is important to note that not all of the buses with 30 minute headways all day were included on this map. The map of all 30 minute buses was too visually crowded, so reaching destinations was an added criteria. The headway of 30 minutes was selected so that no one would be stranded at these destinations, especially those new to the system. The goal of this map was to appeal to tourists as well as occasional riders who would take public transit for special events or to get places without having to deal with parking.

Before creating this map, it was important to define and determine where these "destinations" were. The categories used came from a variety of places, including the MARTA inventory of locations included in their system map and individual route maps, as well as destinations noted on other transit maps, especially the tourist map from the CTA. The following categories were chosen to provide a better understanding of attractions in Greater Atlanta Area:

- Alternate Transportation Mode
- Arts/Entertainment
- Convention Center
- Employment Center
- Government
- Groceries/Food
- Historical Site
- Hotel

- Medical Building
- Mixed Use
- Museum
- Other
- Park
- Residential
- Restaurant
- Retail
- Shopping Center
- Sports Arena
- Tourist Attraction

A list was compiled of the marked destinations listed on the MARTA website by train station. From this, many were excluded as destinations due to closure or classification by the research team as non-destinations. This list was enhanced through the additions of major employers in Atlanta and destinations from Atlanta.net list, *50 Fun Things to See and Do in Atlanta*. Google Maps was then used at each MARTA stop to fill in any missed attractions within two blocks as well as any destinations that either employed many people or had a high capacity for visitors nearby. There were no known lists of the largest business centers or business destinations in Atlanta, so Emporis was used to determine the tallest buildings designated as commercial in Atlanta and thus the most influential business centers in Atlanta.

A line was drawn between the definition of an attraction and a non-attraction using prominence of attractions on the aforementioned websites. Many online databases

were visited to avoid missing destinations or any bias. The final destination list included only destinations that would have an influence on which bus routes to include. The original destination list can be seen in the Appendix.

With regards of selecting bus routes for this map, it was not an exact science. For bus routes to be included, they had to have a headway of at least 30 minutes on weekdays. There were 35 bus routes that met this critiera. This was too many bus routes to include and made the map confusing. As for attractions and popular destinations, they were only added to the map if they were reachable by the bus. Once these were added, there were some bus routes that did not provide service to any attractions and they were removed. This left twelve local bus routes on the map.

3.1.2.3 15 Minute Frequency Map

This map includes all of the bus routes that run at least every fifteen minutes all day. In the transit mapping field, it is generally accepted that with headways less than ten minutes, riders will take transit without looking at a schedule. However, there are no buses in the MARTA system that meet this criteria. For this reason, the threshold was raised to fifteen minutes. In the MARTA system, there are only six routes that run at fifteen minute headways all day. Unfortunately, in the past decade, MARTA has gone through many budget and service cuts, including consolidation of many routes. This has been a contributing factor to the fact that there are no routes that have ten minute service all day and very few have 15 minute headways.

3.1.2.4 15 Minute Peak Frequency Map

This map includes all of the bus routes that run at least every 15 minutes during peak hours (6-9am and 4-7pm). This map included 21 bus routes and showed a more comprehensive system. The peak time period was selected because many trips occur during this time due to commuting to work and school and a time to run errands. This is also when MARTA has the most frequent headways.

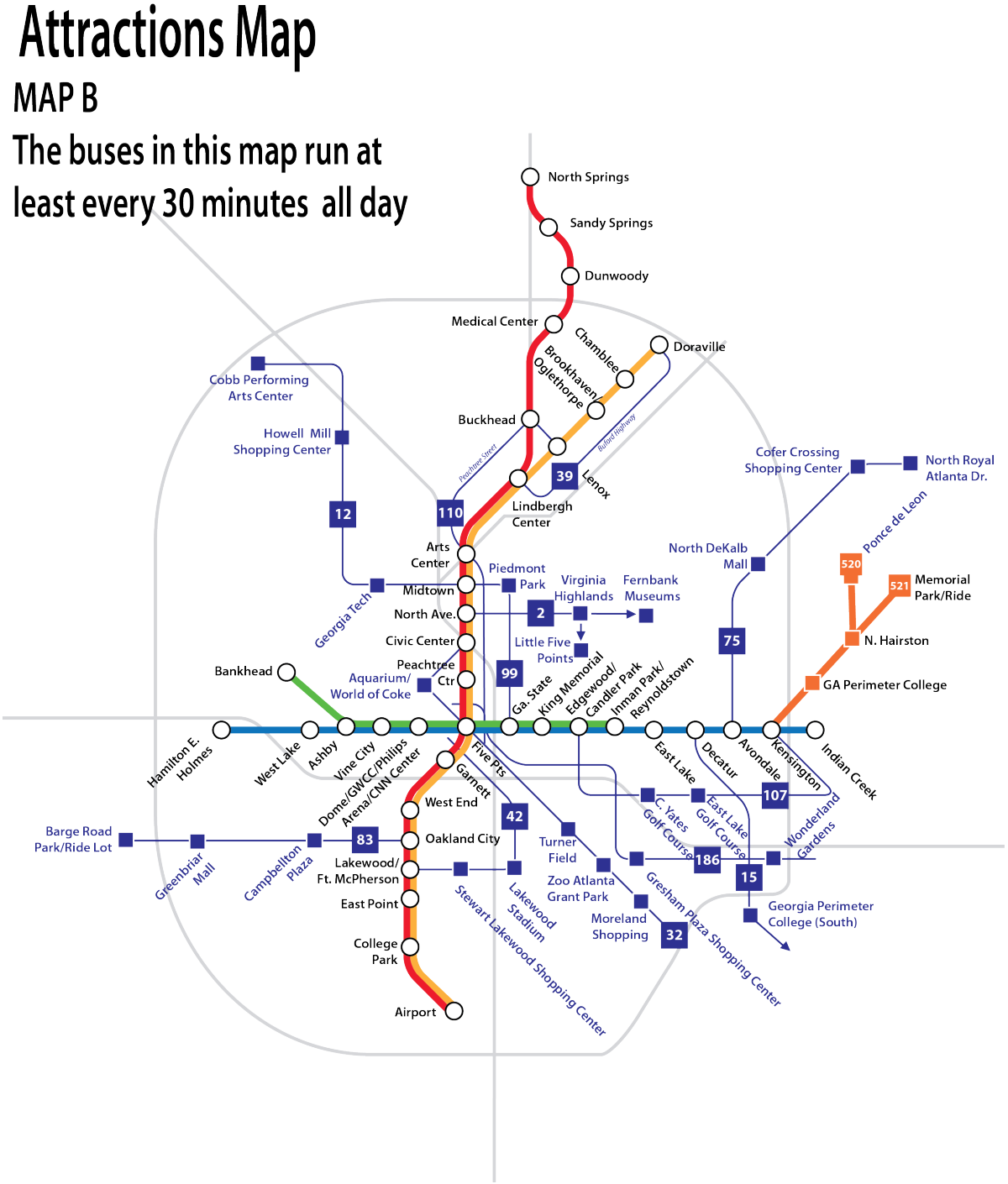


Figure 12: Popular Destination Map

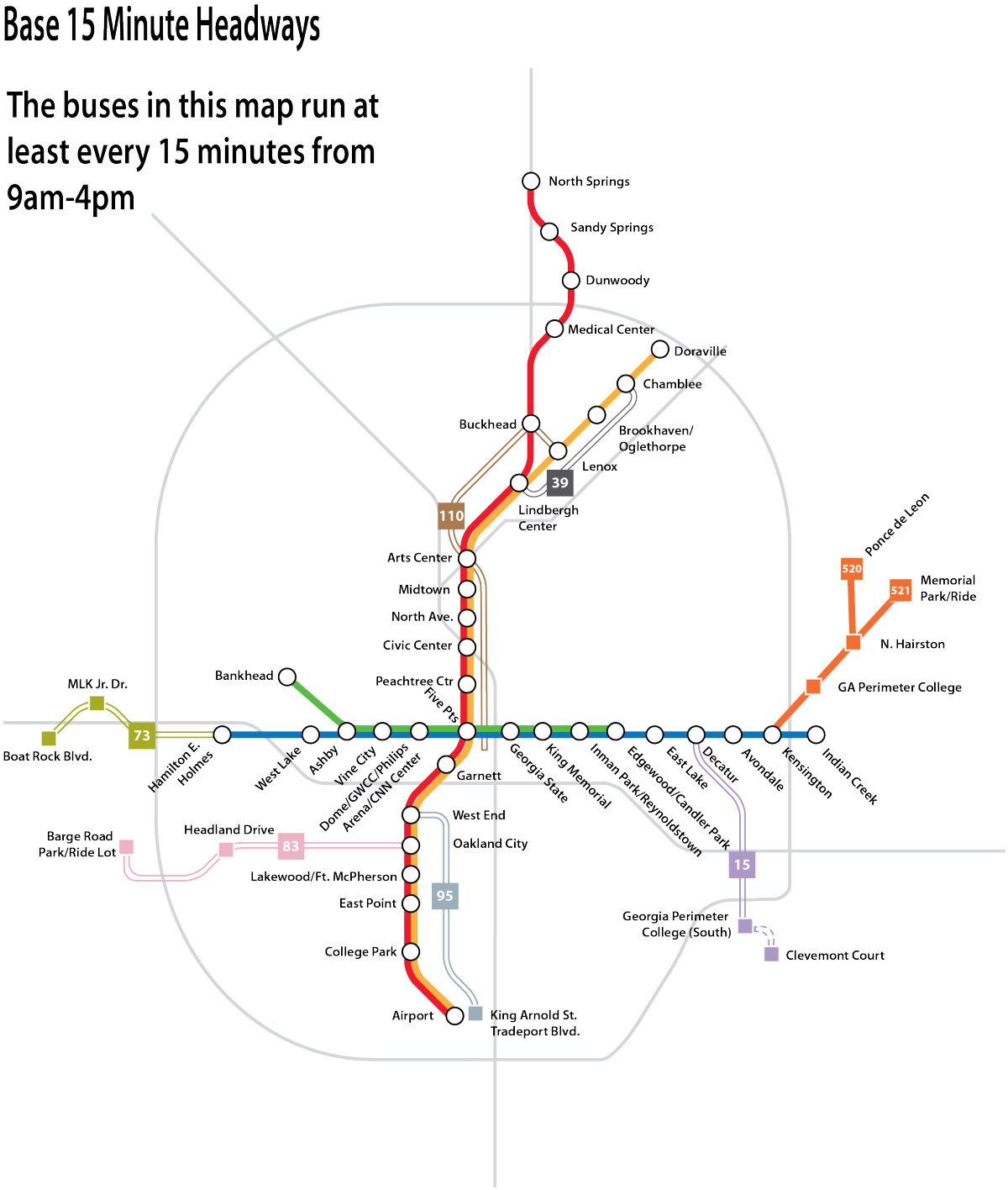


Figure 13: 15 Minute Frequency Map

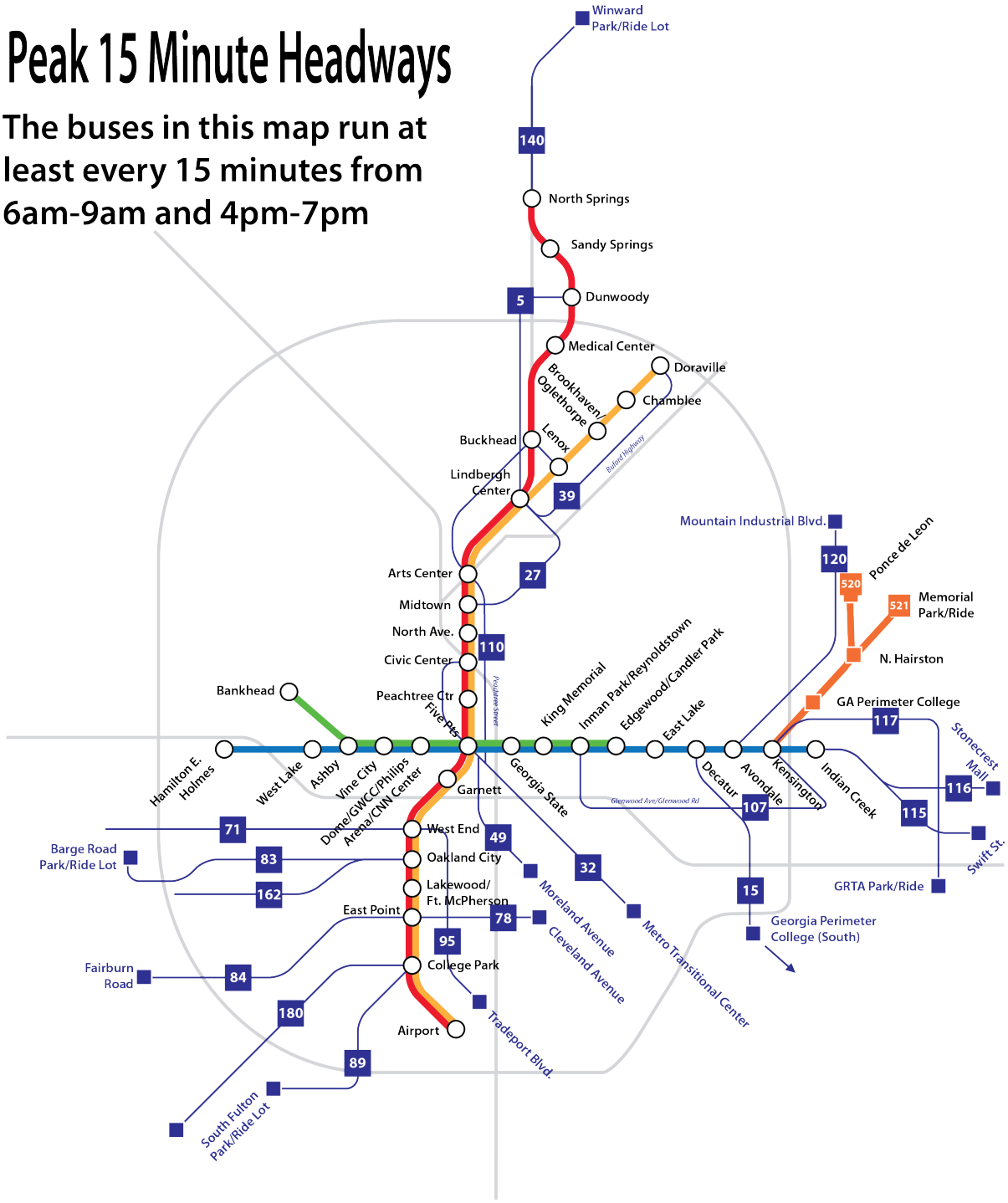


Figure 14: 15 Minute Peak Frequency Map

3.1.2.5 20 Minute Frequency Map

This map includes all of the bus routes that run at least every 20 minutes all day. The research team wanted to test a frequent map as well as an attractions map, but any criteria of less than 20 minutes did not provide an adequate amount of service throughout the system. There were only six routes that met the 15-minute requirement and they did not help to visually create a system that reaches more of the city, one of the goals of the overall project. Extending headways to 20-minutes resulted in ten bus routes and provided better coverage. Destinations were also included in this map simply to help orient the transit riders.

3.2 Surveys Conducted for this Project

Surveys were used so that the project team could collect current ridership, demographic data, as well as opinions and feedback from transit riders and non-riders. These surveys also provided stated preference responses about how these maps could affect their ridership habits and overall understanding of the MARTA system first-hand. There were four main groups of people that this survey strived to reach. These are:

- Train-only riders
- Bus-only riders
- Train and bus riders
- Non-riders

It was important to reach all of these groups because they may respond differently to the multi-modal maps. To reach all types of transit riders and non-riders, two different survey modes were used; on-board and mail-home. An on-board survey is conducted in person, either on-board the train or in the station within the fare

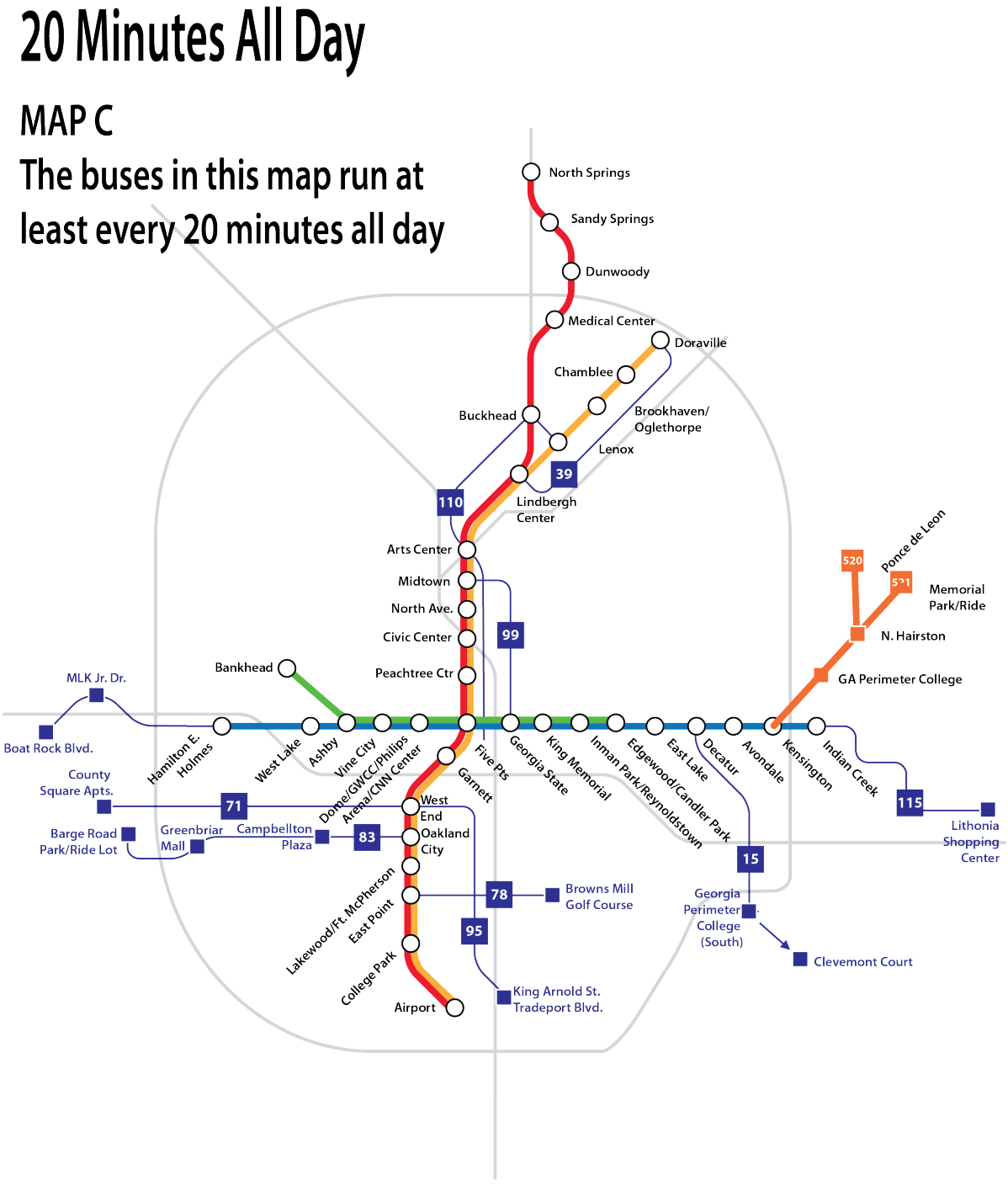


Figure 15: 20 Minute Frequency Map

gates. For these surveys, the surveyor records the participant's responses either on paper or using a tablet/portable computer. A mail-home survey is one that is mailed to the address of the participant. This can include a paper survey to mail back or directions to fill out a survey online. For this project, participants had their choice of completing it online or mailing it back. All of these surveys were approved by the Georgia Institute of Technology Institutional Review Board (IRB). The application is included in the Appendix.

3.2.1 Overall Survey Design

One of the main goals of this survey was to make it easy to administer in person, online, and on paper. The survey created for this mapping project was designed using the book "Internet, Mail, and Mixed-Mode Surveys: Tailored Design Method - 3rd edition" as well as input from professors who had previous survey experience. Some of the important factors that went into the survey design were the expected reading level of the population and ensuring that questions were not ambiguous [6]. Language was a barrier that was difficult to address as none of the in-person survey administrators spoke Spanish and the web and paper versions were only provided in English. Surveyors did not keep a record of how many in the on-board survey declined participation.

The survey was the same for both the on-board and mail-home surveys so that the responses could be compared. This included content and question order. The survey was divided into three sections: (1) ridership information (53%), (2) reactions to the new maps (20%), (3) and demographic information (27%). The ridership information section asked participants about their bus and train ridership habits, and if they do not currently ride the bus, what the main reasons are for this. This section was first so that they would reveal their current ridership information before seeing the new maps.

The mapping response section was next and asked about the usefulness and comprehensiveness of the new maps and how they could affect future bus ridership and system understanding of the participants. While five maps were originally created for this project, only three were included along with the current map for comparison. The three maps included were the *Park and Ride Map*, the *Popular Destinations Map*, and the *20 Minute Frequency Map*. In an effort to get more participants and reduce the amount of time the survey took, the research team wanted to limit the number of maps included. The *20 Minute Frequency Map*, *15 Minute Frequency Map*, and *15 Minute Peak Frequency Map* were all frequency maps and the research team only wanted to include one of these so as not to seem biased towards the importance of frequency. The *20 Minute Frequency Map* was chosen because it covered more of the city than the *15 Minute Frequency Map* and because including bus routes that are only frequent during peak periods may have been confusing for any off-peak riders and would require a further explanation about peak service. While 20 minutes is generally not considered frequent in maps found in the literature review, this map was used in the service because it had better coverage than the 15-minute maps and was relatively frequent in the MARTA bus system that typically has headways of 40 minutes or more. Using 20 minutes as the 'frequent' map may have lead to some participants not finding the map useful or ranking the popular destinations map more useful even though they think that frequency is the more important attribute.

Finally, the demographic questions were last. Some participants were uncomfortable answering the demographic questions or ended the survey because their train was coming. All surveys that were complete through the mapping response section were considered complete. The percent of participants who answered the demographic questions ranged from 60%-85% depending on the question. Income was the question with the smallest response rate. Screenshots of the tablet and web survey as well as a copy of the paper survey can be seen in the appendix.

The total number of surveys in both surveys are summarized in Table 1 as well as the response rates. The on-board survey collected about two and a half times more surveys. This will be explored in the following section.

Table 1: Surveys Collected

Survey Mode	Surveys Collected
Response Rate	
On-Board	349
	96
	0
	253
	90%
Mail-Home	131
	40
	0
	67
	9.89%

3.2.2 On-Board Survey

The on-board train survey was the first survey conducted for this project with permission from MARTA.

3.2.2.1 Purpose

The purpose of the on-board survey was to capture participants who are both train and bus riders as well as those who are train-only riders. These riders have seen the MARTA train map at least once because they have ridden the MARTA train at least once. For those who were train-only riders, their opinion about how these additional bus routes could affect their travel was especially important. For those who already ride the bus and the train, the research team was interested in whether these route additions would help orient them in the system, or if it could increase their bus ridership on routes they do not ride routinely.

3.2.2.2 Administration

The on-board survey was conducted April 30, through May 4, 2012, Monday through Friday, by nine surveyors who all received human subjects training. All of these

surveys were conducted between the hours of 6 A.M. and 7 P.M. due to limited availability of surveyors and safety. Prior to conducting the survey, a training session was held and all surveyors attended. To make data collection and input easier, a tablet application was developed in house at Georgia Tech to record on-board responses on tablets. This training session included how to use the Toshiba Tablets, where to conduct the surveys during particular time periods, and how to conduct the survey with participants.

To obtain a random sample, surveyors were assigned a section of the MARTA train system; north, south, east, or west. Instructions were to randomly stop at stations and survey riders who were waiting for trains in both directions. The instructions were to select random participants, such as every fourth person who comes down the stairs. In this way, riders originating from all parts of the MARTA train system were surveyed during both peak and non-peak hours. Upon approaching a potential participant, all surveyors read the following paragraph explaining the survey:

"Hi my name is Margaret and I am a graduate student at Georgia Tech. We are conducting a survey about MARTA train and bus maps. The results will be used to improve the overall MARTA system maps. Do you have about 10 minutes to answer some questions? This will not cause you to miss your train if it comes. At any time you may stop the survey or you may choose not to answer a specific question."

The survey took seven to fifteen minutes depending on how interested participants were. Some finished the survey as fast as they could, while some thought that the new maps were interesting and chose to discuss them further. There were also some train riders who wished to voice other opinions about MARTA that were not relevant to the survey.

The only issue with the on-board survey was that the tablet application was not ready for Monday, April 30. Because of time restrictions, surveyors collected responses

on paper for the first day. To make it as similar to the tablet experience as possible, the surveyors still filled out the survey instead of the participants. Participants were asked the same questions in the same order as when the tablets were used. Tuesday through Friday, the tablets were used and the survey was conducted electronically. To create a database with all on-board responses, all 79 surveys that were collected on Monday were collected by hand and entered into the database. A summary of the completed on-board surveys can be seen in Table 2. The response rate for the on-board survey was not recorded. Based on the experience of the surveyors, the team estimated a response rate of 90 percent. The target sample size was 350, so the amount of surveys collected on Thursday and Friday were fewer than the first three days because it became clear that the target would be reached. The final number was 349 after incomplete responses were removed.

Table 2: On-Board Surveys Collected

Monday	79
Tuesday	117
Wednesday	106
Thursday	38
Friday	16
Total	356

3.2.3 Mail-Home Survey

The mail-home survey was conducted in three mailings from August, 2012 through January, 2013.

3.2.3.1 Purpose

The purpose of the mail-home survey was to obtain opinions and responses from bus-only and non-transit riders. The neighborhoods where the mail-home survey were sent were chosen based on location. Four neighborhoods in Atlanta were also selected

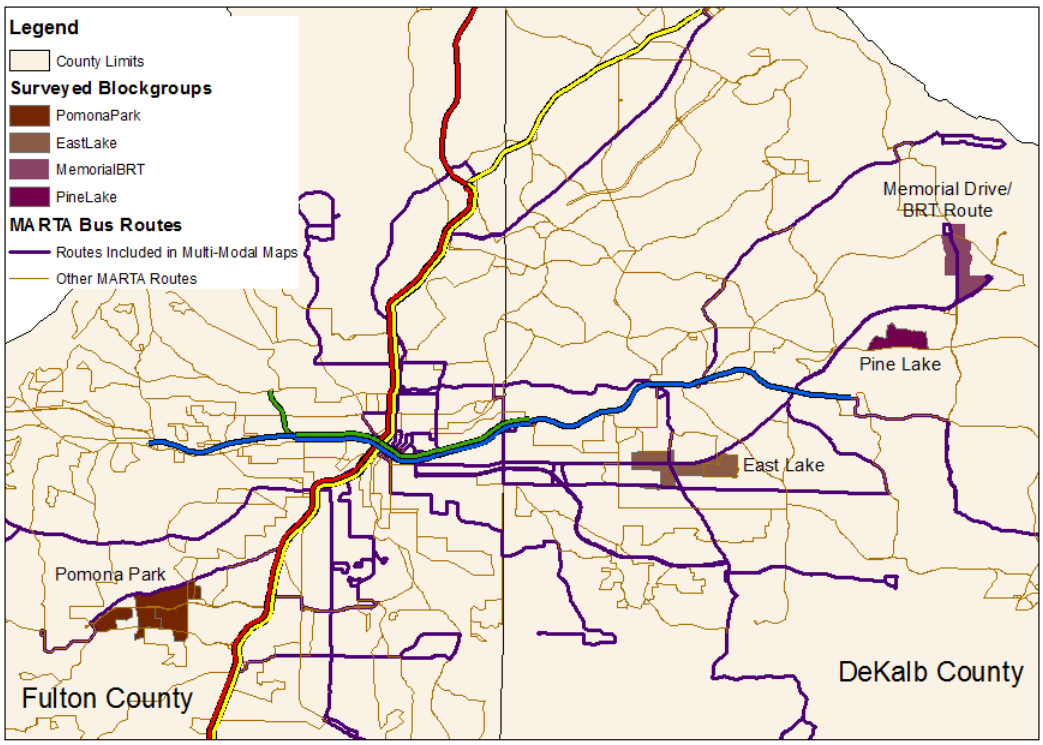


Figure 16: Mail-Home Survey Neighborhoods

that were at least one mile from a MARTA train station and were located near bus routes included on the maps. Each neighborhood was selected to capture a range of demographic factors.

The data for these addresses was purchased with 100 % coverage for census blockgroups within those neighborhoods. From these selected neighborhoods, 2,000 households were randomly selected. Because of the data organization, the blockgroup outlines used were from the year 2000 census blockgroup area but with current demographic information. The four neighborhoods selected can be seen in Figure 16 and are summarized below.

Pomona Park The blockgroups in this neighborhood are in southwestern Atlanta along Campbellton Road and Langford Parkway. Pomona Park was selected because multiple bus routes in multiple maps run through this area. The majority of these routes are feeders into the Fort McPherson MARTA Transit Station. The expected demographics in this neighborhood were generally lower income and a majority Black population.

East Lake East Lake neighborhood is located in the easternmost part of the Atlanta city limits, where the East Lake Golf Club is located. The neighborhood was one of the more affluent neighborhoods and has a higher White population percentage than others located near some of the bus routes included in the multi-modal maps. It was important to select neighborhoods with different income levels and ethnic makeups so that the income demographic could be compared.

Memorial Drive/BRT Route The blockgroups that represent this neighborhood are along both sides of Memorial Drive in DeKalb. Households along the BRT route were selected to see how they responded to a system transit map that included the enhanced bus route along Memorial Drive. In this corridor, the bus has both transit signal priority at some of the intersections as well as the ability to queue jump during congested times.

Pine Lake Pine Lake is the smallest city in DeKalb County. This city is located close to some of these bus routes, but the street configuration makes accessing the arterials difficult. It was important to see the reactions of these residents to see if they knew that there was bus service close by and how they currently use it as well as how these maps could influence their ridership.

A total number of 6,554 household addresses were purchased and from this 2,000 were randomly selected. The breakdown by neighborhood can be seen in Table

3.

Table 3: Sampling Number

	BRT	East Lake	Pine Lake	Pomona Park	Total
Sample	603	516	224	657	2000
100% Purchased Data	2016	1680	729	2129	6554

3.2.3.2 Administration

The web/mail-home survey was conducted in three rounds; a letter with online username and password, a reminder postcard for the online survey, and a paper version. The first mailing was sent out 8/6/2012. However, there was a glitch in the online survey that prevented participants from logging in for the first day. The problem was fixed within hours of it being discovered. Because it was caught so quickly, it did not present a significant loss in potential participants. The next month, on 9/14/2012, a reminder postcard was sent out apologizing for the technical difficulties and reminding the potential participants of their unique usernames and passwords. There were no technical glitches this time. Finally, the paper version was sent out on 11/26/2012. This included a letter, the survey, copies of the maps, and was pre-addressed for easy return to Georgia Tech. This survey included instructions to fold the survey, tape it shut, and mail it back. The back page of the survey included a business reply mail bar code so that participants did not have to pay for postage. All items included in the mailings can be seen in the Appendix.

Whether participants took the survey online or using the paper version, the following paragraph was presented so that they knew what was involved in the survey and their potential reward. Table 4 summarizes how many surveys were completed after each mailing. The response rate was very low, 9.96%, and will be further examined in the following chapter.

"Welcome to the MARTA Mapping Survey. Thank you for your participation in

Table 4: When/How Participants Completed the Survey

Online (1st Mailing)	Online (2nd Mailing)	Paper (3rd Mailing)
38	21	79

this survey. You must be 18 years or older to complete it. The survey should take approximetaly 10-15 minutes to complete. Your participation in this survey is voluntary and completion of this survey provides your consent to participate. Your answers to this survey will be stored on a secure server at the Georgia Institute of Technology and will not be released in connection with your address. As a reward for participating in this survey you will be entered into a drawing to win a 75$ Gift Certificate to Target. Thank you for your participation, it will greatly help our research."

Regardless of whether the participants completed the survey online or mailed it back, they were entered into the reward drawing with the same chance of winning.

3.3 Sample Comparison Plan

While the survey team strived for a random sample, it cannot be assumed that the sample was random. To test the randomness of the sample and identify any of the potential bias that may exist, demographic data from the two surveys are compared with known samples and populations in the following chapter.

The on-board rail survey demographic data will be compared with the ARC Regional On-Board Transit Survey. There are no demographic data for the population of all MARTA train riders. However, comparing to a much larger sample from the same population will provide an adequate estimate of randomness. Since these are two samples, a chi-square test cannot be performed directly (further explained in section 4.1). Instead, the bootstrapping method will be used to assess the 95% confidence interval of each demographic category, which will be compared to the data collected in the on-board survey for this project.

For the mail-home survey, the complete population demographic data are available through census data. The demographic data are available online from the Census FactFinder for most blockgroups. The mail-home survey was performed for four separate neighborhoods. Each neighborhood and the overall sample will be compared with the demographic data for each available blockgroup. In this case, the sample and the entire population are known, so a chi-square test will be used.

3.4 Analysis Plan

The analysis for these surveys will be discussed in four chapters. Chapter five will discuss the responses to all of the survey questions. Chapters six, seven, and eight will address the following "key" research questions asked in the surveys:

- "Is it more important for maps to include bus and train routes that reach popular destinations or that come more often?"
- "If one of these maps replaced the current MARTA overall maps, would you ride the bus more?"
- "If one of these maps replaced the current MARTA overall map, would it help your understanding of the overall MARTA system?"

The responses to these questions are important to understand the effects that these maps could have on current riders and potential new riders. They address goals of the project including transit ridership and map understanding, and how they are related. They also address what participants want to see on overall maps so that they are comprehensive, easy to understand, and facilitate ridership. Finally, conclusions and multi-modal mapping recommendations will be made based on the survey results.

CHAPTER IV

DATA DESCRIPTION AND SAMPLE COMPARISONS

The purpose of this chapter is to describe the data that were collected through multiple survey modes in this project as well as examine the data and address any bias that may exist. Table 5 summarizes the two survey totals.

Table 5: Surveys Collected

Survey Mode	Surveys Collected
On-Board	349
Mail-Home	138

4.1 On-Board Survey Response Data

For the on-board survey, a total of 349 surveys were collected. Of these, seven were recorded as persons under eighteen and will not be included because of IRB restrictions. Based on reports from surveyors, approximately 90% of people approached in MARTA stations participated in the survey. Each surveyor was assigned a two to four hour block of surveying a particular section of the rail system. Figure 17 shows the breakdown by station of surveys collected. At least one survey was completed at each MARTA station.

To test if the on-board survey sample is representative of the population of MARTA train riders, ideally, the demographic data would be compared to the entire population. However, these data are not available. Instead, the demographic data were compared to the *Regional On-Board Transit Survey* completed by the Atlanta Regional Commission (ARC) from 2009-2010. The survey conducted by ARC was an extensive on-board survey that was conducted in all MARTA train stations as

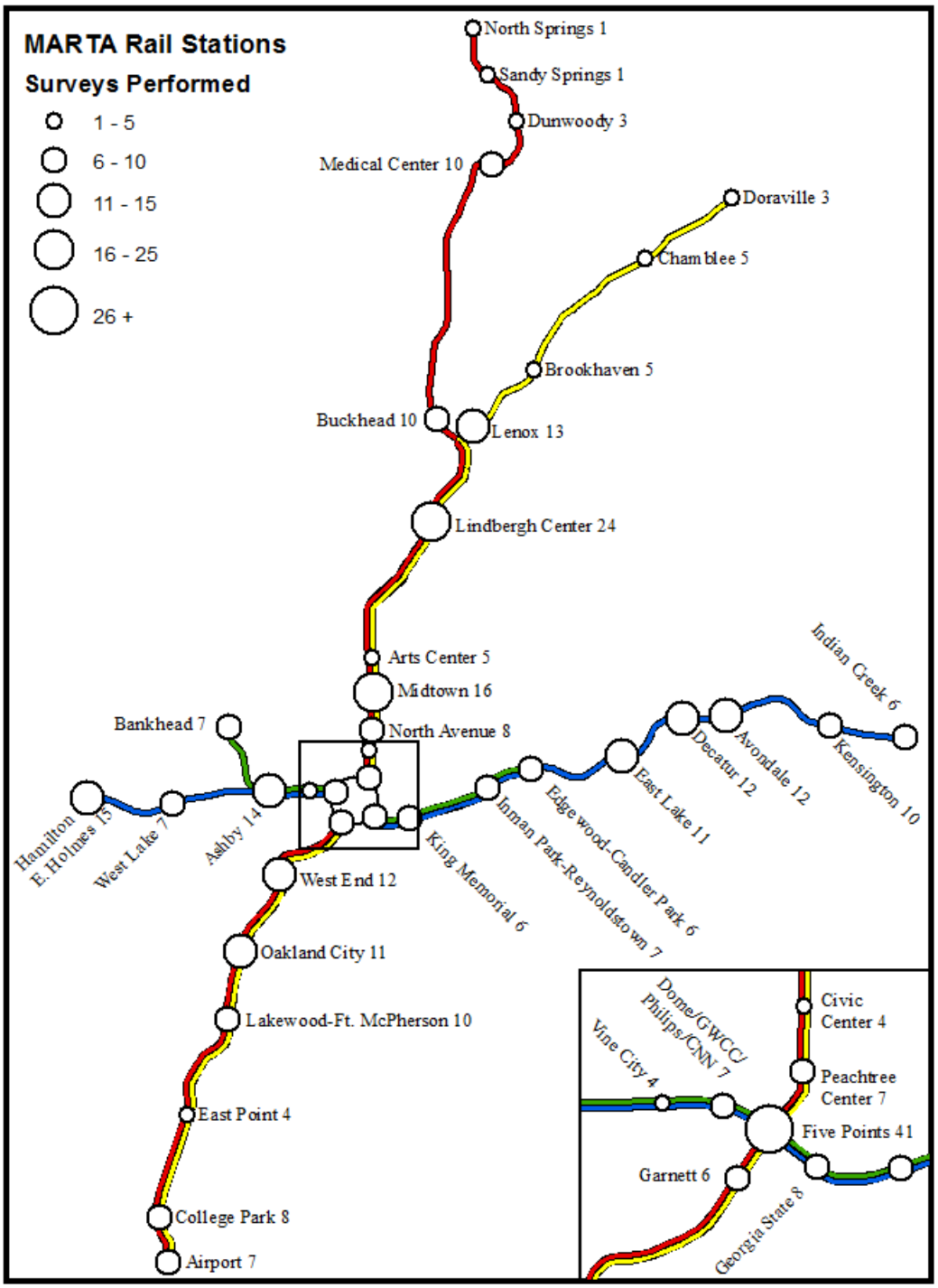


Figure 17: Number of Surveys Collected at each MARTA Train Station

well as on board MARTA buses. In addition to being conducted on board MARTA buses and trains, the ARC survey was also conducted on buses in the region operated by Cobb Community Transit, Gwinnett County Transit, Clayton County Transportation, Cherokee Area Transit System, and the Georgia Regional Transportation Authority.

To conduct the comparison, only the surveys completed in the ARC survey in MARTA train stations from 6a.m. to 7p.m. were used. The number of responses that met these criteria in the ARC survey totaled 20,342 responses out of the total 56,647 surveys completed by ARC. All of the ARC surveys were conducted on weekdays, same as the on-board survey for this project.

For comparison, the following demographic categories were used:

- Ethnicity
- Household Size
- Household Vehicles
- Gender
- Licensure
- Age
- Household Income

Each of these categories was examined individually to see how similar or dissimilar the two samples are, assuming that they came from the same population of MARTA transit riders. Comparing the responses to the ARC survey and the on-board mapping survey is a comparison of two samples instead of a sample and a population, a chi-square calculation is not applicable.

The null hypothesis here is that the two samples came from the population. To examine whether these samples came from the same population, the bootstrapping method was used on the ARC data. From the 20,342 relevant ARC responses a random selection of 356 was picked 1,000 times. Bootstrapping takes many samples of the ARC data and produces a range and a mean for the percentage of each demographic category. Using the calculated mean and standard deviation, a 95 % confidence interval was calculated using the equations below. Figures 18 through 20 show the percentage of each ethnicity in the tablet mapping survey as dots and the confidence interval of the ARC data as lines.

$$\textit{confidence interval low value} = \mu - 1.96 * \sigma \tag{1}$$

$$\textit{confidence interval low value} = \mu + 1.96 * \sigma \tag{2}$$

Figures 18 through 20 show the results of the bootstrapping for all of the examined demographic categories as represented by lines. The dots on the figures are the proportions found in the on-board survey. If the dot is located within the confidence interval line, it is reasonable to assume that they came from the same populations and that the sample is random. If not, there may be some bias in that particular demographic category.

Based on Figure 18, this project under-sampled the Black and White ethnicities and oversampled the Asian and Other populations. One explanation of oversampling of ethnicities that were not Black nor White could be that participants were only allowed to choose one ethnicity. Some participants may have selected Jewish while also belonging to another ethnic group. Some participants refused to respond to any ethnicity other than Native American because they were born in America, regardless of which cultural ethnicity they identify with. These two categories may have claimed participants who would have answered Black or White if these other ethnicities were

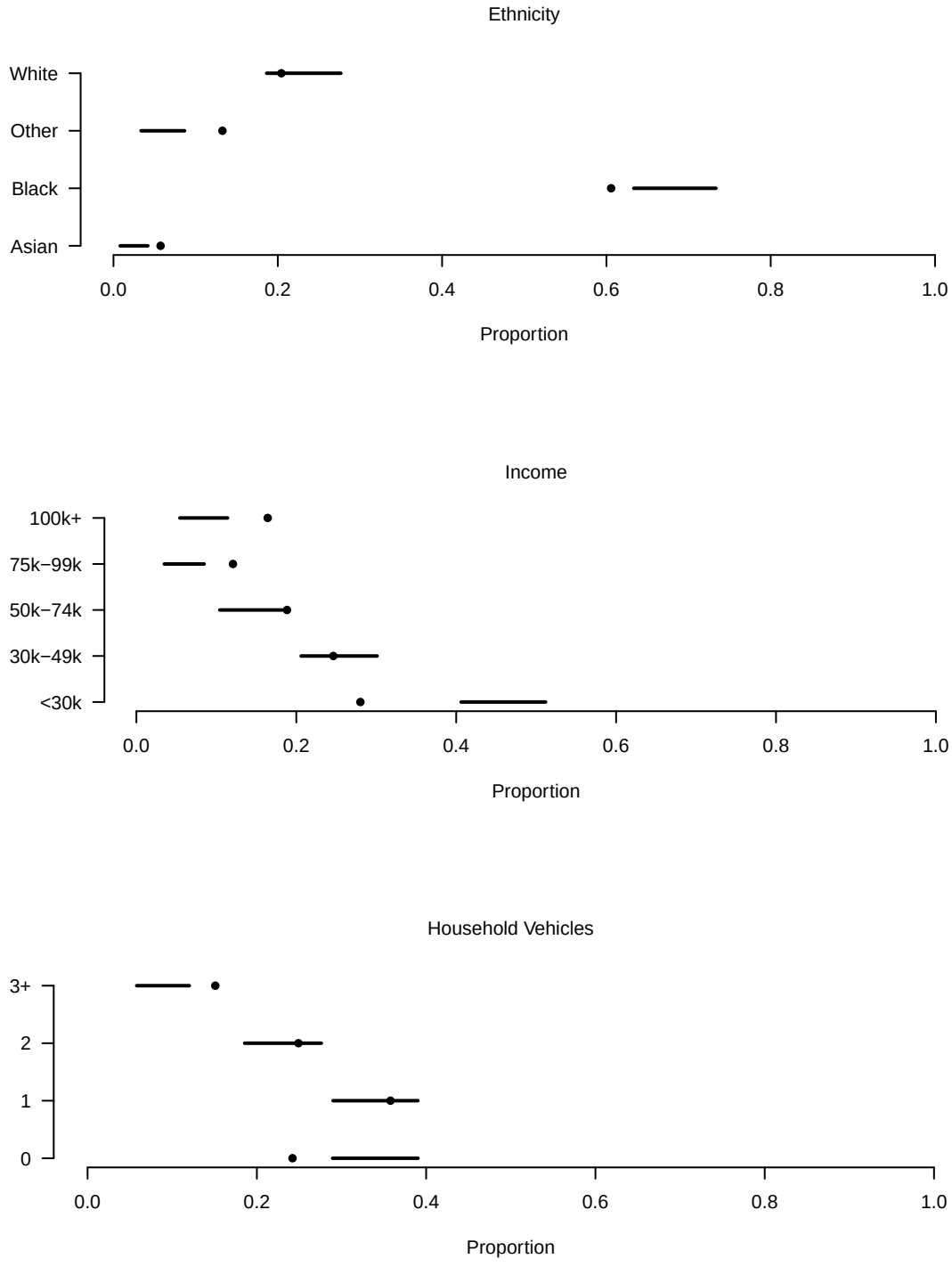


Figure 18: On-Board Survey/ARC Demographic Comparisons

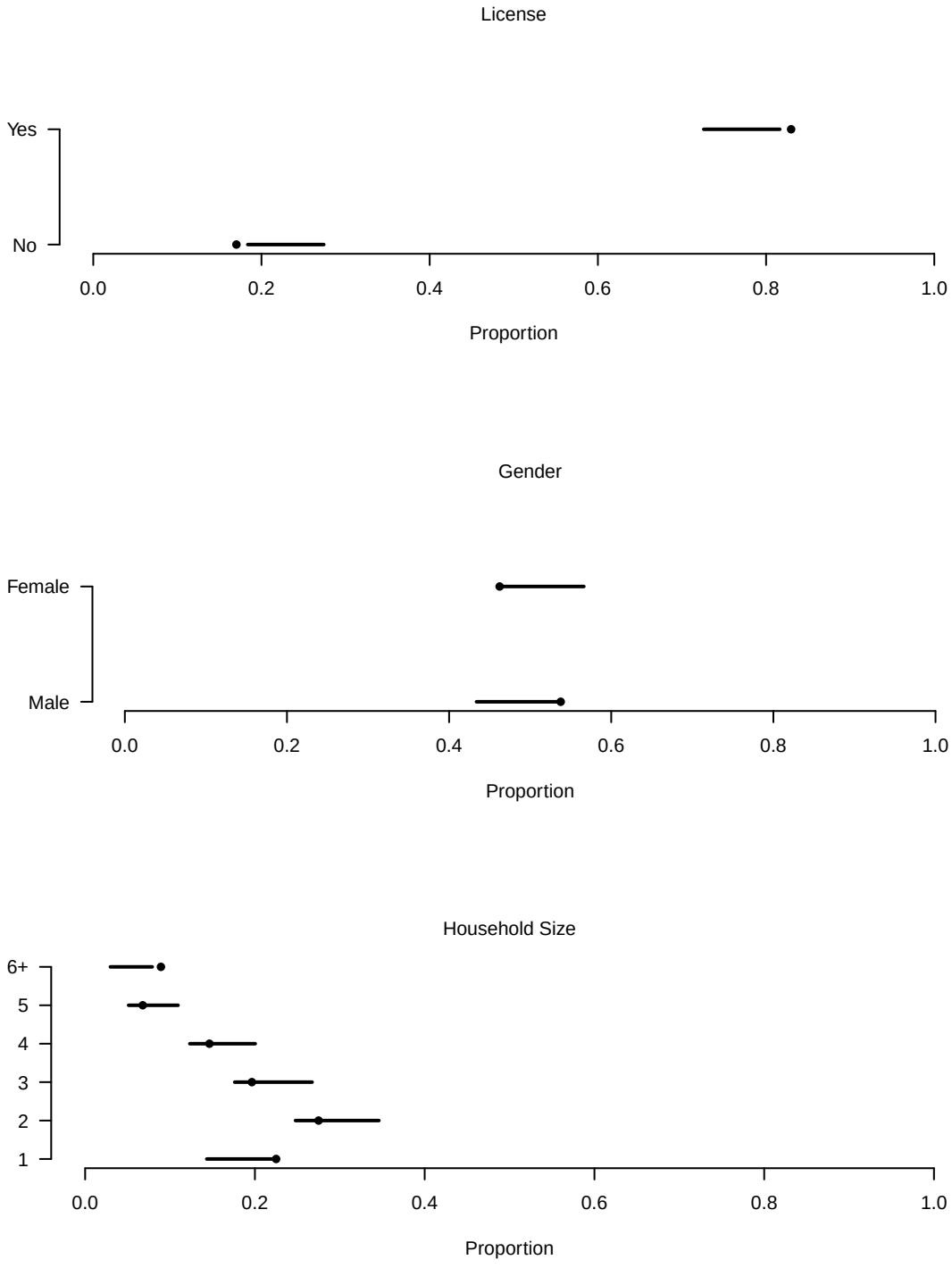


Figure 19: On-Board Survey/ARC Demographic Comparisons (continued)

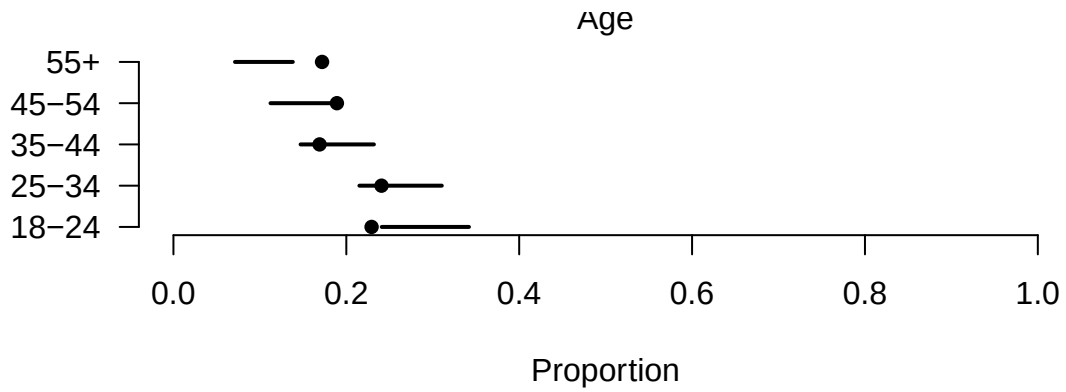


Figure 20: On-Board Survey/ARC Demographic Comparisons (continued)

not included or if questions of race and ethnicity had not been asked together. Additionally, it may be that surveyors subconsciously oversampled under-represented groups. The large majority of MARTA riders are Black or White and surveyors may have wanted to ensure that they surveyed minorities, which lead to oversampling them. They were categorized together so that the data could be compared to the ethnicity data purchased along with the purchased address data for further analysis outside of this thesis.

It is also important to note that the entire survey team was White except for one surveyor who was Asian/Hispanic. The ethnicity of the surveyors may have affected willingness to respond to the survey for various ethnicities.

The distributions of income and household vehicles were similar. The survey oversampled households with higher incomes and more vehicles and under-sampled households with lower income and fewer vehicles.

This survey found fewer riders without a license and more with valid drivers licenses than the ARC survey, as seen in Figure 19. Additionally, this survey sampled slightly less women and slightly more men than the ARC confidence interval suggested

by sampling the ARC Data, but are both within an acceptable range.

Based on Figures 18 through 20, the mapping survey captured slightly more people in single-person households and in large households, but it is reasonable to say they came from the same population. With regards to age, this survey collected more participants in the age group over fifty-five. Due to time restrictions of the surveyors, many surveys were conducted during the middle of the day when fewer people ages 18-54 are riding transit because of work or school obligations.

While, the responses to this mapping survey were slightly biased towards households with higher incomes, more vehicles, licensed drivers, and Asian and Other ethnicities, it was an overall representative sample, assuming that the ARC survey data are the true values, which may not be exactly true. However, these slight biases is not necessarily a bad thing. Participants in these households and whom are licensed, have more vehicles, and have higher income are more likely to be choice riders instead of transit dependent riders. The fact that this survey is biased towards choice riders is makes the survey results more conservative. Transit-dependent riders will ride transit and figure out the map and the schedule because they have to. Choice riders are the ones who may be more willing to take transit if the information and coverage was easier to understand. The goal of these maps is to publicize more coverage by buses that is not often seen and make the transfers easier to navigate. This sample is inadvertently biased towards the target audience.

4.2 Mail-Home Survey Response Data

A total of 138 responses were received through the mail-home survey. This number includes surveys that were completed both online and in paper form.

The first mailing produced 38 responses and the reminder postcard produced 21 responses, all using the online interface. After the third mailing, 80 paper surveys were returned, as seen in Table 6. Overall, a total of 138 surveys were returned out

of the original 2,000 (6.9 %) mailed out and of the 1395 (9.89 %) legitimate addresses from those original 2000 selected. Of these 139, 23 were either partially or entirely incomplete. The response rate for completed surveys is 5.80 % out of the original 2,000 sent and 8.32 % out of the 1,395 valid household addresses

One of the number of reasons the sample number was low was the address data that was purchased. Of the 2,000 randomly selected addresses from the 6,554 that were purchased, 605 were returned for various reasons. Table 7 details the reasons for nondelivery as stated by the postal service. Part of the reason for non-delivery was that the survey letters were addressed to the head of household listed by the purchased data. Altogether, 30.25% letters that were mailed out were returned.

Table 6: When/How Participants Completed the Survey

Online (1st Mailing)	Online (2nd Mailing)	Paper (3rd Mailing)
38	21	79

Table 7: Reasons for Non-Delivery

	Retured
Not deliverable as addressed, unable to forward	242
Attempted, not known, unable to forward	184
Vacant	27
Forward time expired	10
No such number	4
Insufficient address	11
Undeliverable as addressed, unable to forward	5
Unable to forward	4
No mail receptacle	1
Moved, address known	108
No such street	9
Total	605

Examining the reasons for nondelivery, the ones that were the reason for the majority being returned were “not deliverable as addressed, unable to forward”, “attempted, not known, unable to forward”, and “moved, address known”. These are

all reasons indicating that resident that the envelope was addressed to no longer lives there. The majority of people who have recently moved are renters, as they are more apt to move than homeowners. Upon further examination of the data, only 31% of original addresses were listed as apartments, but of the returned addresses, 50% were addresses. The amount of apartment addresses that were invalid indicates that the credit reporting data that were purchased were biased towards homeowners when including the resident name.

To test the data and examine any possible bias, the demographic responses in the mail-home survey were compared to the 2010 census data for the selected blockgroups, which includes aggregated demographics for most blockgroups. To test the demographic data against non-aggregated data, demographics from the ARC Household Travel Survey were the first choice. However, there were only 36 households in all of the desired blockgroups which was not enough for a comparison, so the aggregated census data were used.

Because the number of surveys collected (139) was small, the comparison will be aggregated and analyzed for each neighborhood individually and for the overall sample. The data for some blockgroups is not available because some of the totals in those blockgroups are small and it would be easy to identify which households they are, and are therefore not released by the Census Board. Only the available blockgroups and surveys completed in those block groups were used for comparison. The 2010 blockgroups used in this survey:

- Pine Lake
  - 130890209094 (no data available)
- East Lake
  - 130890208021 (age, houshold size, race, tenure, income available)
  - 130890208024 (age, houshold size, race, tenure, income available)

  - 130890231012 (age, houshold size, race, tenure, income available)

- Pomona Park
  - 131210076032 (age, houshold size, race, tenure available)
  - 131210076041 (race available)
  - 131210077052 (age, houshold size, race, tenure available)
  - 131210113011 (age, houshold size, race, tenure, income available)
  - 131210113016 (age, houshold size, race, tenure, income available)

- Memorial Drive/BRT Route Corridor
  - 130890209111 (no data available)
  - 130890209112 (no data available)
  - 130890219101 (age, houshold size, race, tenure available)
  - 130890219082 (age, houshold size, race, tenure, income available)

Tables 8 through 11 show the raw totals and percentages for the census data and survey responses for ethnicity, household size, age, tenure, and income. To compare the population and the sample, the difference between percents is presented. The difference in the level of magnitude between the census and the number of survey responses that fall in each category makes chi-square tests unreliable. Percentages that are green indicate that there is less than a difference of ten percent between the two distributions and red indicates larger than that. If the difference is more than ten percent, it indicates a possible bias in the sample collected for this survey.

The East Lake neighborhood comparison summary can be seen in Table 8 and shows two demographic categories with large differences from the census data; ethnicity and tenure. There were more White participants in the survey from East Lake despite the fact that the census reports a Black majority in these blockgroups.

Table 8: East Lake Demographic Chi-Square Tests

East Lake					
	Census Population		Mail-Home Survey Sample		Difference of Percents
Ethnicity	N	%	N	%	
White	1027	31.24%	30	63.83%	32.59%
Black	2202	66.99%	14	29.79%	-37.20%
Asian	35	1.06%	0	0.00%	-1.06%
Other	23	0.70%	3	6.38%	5.68%
Household Size	N	%	N	%	
1	400	29.15%	9	18.75%	-10.40%
2	458	33.38%	20	41.67%	8.28%
3	264	19.24%	11	22.92%	3.67%
4	134	9.77%	6	12.50%	2.73%
5	68	4.96%	0	0.00%	-4.96%
6+	48	3.50%	2	4.17%	0.67%
Age	N	%	N	%	
18-24	257	9.65%	1	1.69%	-7.95%
25-34	620	23.27%	15	25.42%	2.15%
35-44	592	22.22%	15	25.42%	3.20%
45-54	505	18.96%	15	25.42%	6.47%
55+	690	25.90%	13	22.03%	-3.87%
Tenure	N	%	N	%	
Mortgage	710	51.79%	5	10.64%	-41.15%
Own	174	12.69%	34	72.34%	59.65%
Rent	487	35.52%	8	17.02%	-18.50%
Income	N	%	N	%	
Less than $30,000	347	44.72%	7	15.22%	-29.50%
$30,000-$49,999	164	21.13%	6	13.04%	-8.09%
$50,000-$74,999	157	20.23%	11	23.91%	3.68%
$75,000-$99,999	78	10.05%	9	19.57%	9.51%
$100,000 and up	30	3.87%	13	28.26%	24.39%

Source: 2000 Census

With regards to tenure, a significant majority of those that participated in the survey were homeowners, which left renters under-sampled. Other than that, East Lake was under-sampled for single-person households and households with annual income in the lowest and highest income brackets.

Table 9 summarizes the Pomona Park comparison. The categories in Pomona Park demographics which are much different than the census data are the tenure, household size, and income. The tenure is biased towards homeowners and under-surveyed renters. In the household category, single-person households were under-surveyed and two person households were over-surveyed, but households of three or

Table 9: Pomona Park Demographic Chi-Square Tests

Pomona Park					
	Census Population		Mail-Home Survey Sample		Difference of Percents
Ethnicity	N	%	N	%	
White	299	6.09%	2	5.88%	-0.21%
Black	4534	92.36%	29	85.29%	-7.07%
Asian	19	0.39%	1	2.94%	2.55%
Other	57	1.16%	2	5.88%	4.72%
Household Size	N	%	N	%	
1	1279	50.90%	8	24.24%	-26.65%
2	624	24.83%	15	45.45%	20.62%
3	292	11.62%	4	12.12%	0.50%
4	163	6.49%	3	9.09%	2.60%
5	86	3.42%	2	6.06%	2.64%
6+	69	2.75%	1	3.03%	0.28%
Age	N	%	N	%	
18-24	412	10.19%	1	2.50%	-7.69%
25-34	572	14.15%	0	0.00%	-14.15%
35-44	517	12.79%	7	17.50%	4.71%
45-54	671	16.60%	10	25.00%	8.40%
55+	1871	46.28%	22	55.00%	8.72%
Tenure	N	%	N	%	
Mortgage	519	20.65%	7	20.59%	-0.06%
Own	201	8.00%	17	50.00%	42.00%
Rent	1793	71.35%	10	29.41%	-41.94%
Income	N	%	N	%	
Less than $30,000	209	32.91%	5	38.46%	5.55%
$30,000-$49,999	205	32.28%	6	46.15%	13.87%
$50,000-$74,999	138	21.73%	1	7.69%	-14.04%
$75,000-$99,999	32	5.04%	0	0.00%	-5.04%
$100,000 and up	51	8.03%	1	7.69%	-0.34%

Source: 2000 Census

more were adequately represented percentage-wise, however it is important to note how few large households exist in either sample. With income, the $30,000-$49,999 and $50,000-$74,999 were under- and over-surveyed respectively.

The blockgroups surveyed along Memorial Drive are summarized in Table 10. Here, income and tenure were the ideographic categories that had the most differences. Again, along Memorial Drive homeowners and under-sampled renters were over-sampled. With regards to income, there were only three participants that shared their income and they were all in the lowest income bracket, which skewed the difference of percents. Other than that, there were various categories in age and household

Table 10: Memorial Drive/BRT Route Demographic Chi-Square Tests

Memorial Drive/BRT					
	Census Population		Mail-Home Survey Sample		Difference of Percents
Ethnicity	N	%	N	%	
White	292	6.53%	0	0.00%	-6.53%
Black	3684	82.32%	10	83.33%	1.01%
Asian	279	6.23%	0	0.00%	-6.23%
Other	220	4.92%	2	16.67%	11.75%
Household Size	N	%	N	%	
1	712	37.93%	6	50.00%	12.07%
2	450	23.97%	3	25.00%	1.03%
3	311	16.57%	1	8.33%	-8.24%
4	193	10.28%	0	0.00%	-10.28%
5	114	6.07%	1	8.33%	2.26%
6+	97	5.17%	1	8.33%	3.17%
Age	N	%	N	%	
18-24	491	13.75%	1	4.17%	-9.59%
25-34	915	25.63%	3	12.50%	-13.13%
35-44	682	19.10%	6	25.00%	5.90%
45-54	607	17.00%	7	29.17%	12.16%
55+	875	24.51%	7	29.17%	4.66%
Tenure	N	%	N	%	
Mortgage	374	19.93%	1	8.33%	-11.59%
Own	35	1.86%	7	58.33%	56.47%
Rent	1468	78.21%	4	33.33%	-44.88%
Income	N	%	N	%	
Less than $30,000	438	54.68%	3	100.00%	45.32%
$30,000-$49,999	217	27.09%	0	0.00%	-27.09%
$50,000-$74,999	121	15.11%	0	0.00%	-15.11%
$75,000-$99,999	6	0.75%	0	0.00%	-0.75%
$100,000 and up	19	2.37%	0	0.00%	-2.37%

Source: 2000 Census

size that were over- or under-sampled, however the total number of participants in the neighborhood surrounding Memorial Drive was small, so one response could drastically change the percent in one category.

Overall, the two demographic categories that were different than the census data were tenure and ethnicity. In all three neighborhoods where census data were available, tenure was very different. The whole survey is biased towards homeowners. This bias towards homeowners may have to do with the address data that were purchased. Of the 605 addresses whose letters were returned, 50% were from apartments

Table 11: Overall Demographic Chi-Square Tests

Overall					
	Census Population		Mail-Home Survey Sample		Difference of Percents
Ethnicity	N	%	N	%	
White	1618	12.77%	32	35.16%	22.40%
Black	10420	82.24%	51	56.04%	-26.19%
Asian	333	2.63%	1	1.10%	-1.53%
Other	300	2.37%	7	7.69%	5.32%
Household Size	N	%	N	%	
1	2391	41.50%	23	27.71%	-13.79%
2	1532	26.59%	28	33.73%	7.14%
3	867	15.05%	16	19.28%	4.23%
4	490	8.51%	9	10.84%	2.34%
5	267	4.63%	3	3.61%	-1.02%
6+	214	3.71%	4	4.82%	1.10%
Age	N	%	N	%	
18-24	1160	11.29%	3	2.44%	-8.85%
25-34	2107	20.50%	18	14.63%	-5.87%
35-44	1791	17.43%	28	22.76%	5.34%
45-54	1783	17.35%	32	26.02%	8.67%
55+	3436	33.43%	42	34.15%	0.71%
Tenure	N	%	N	%	
Mortgage	1603	27.83%	13	13.98%	-13.85%
Own	410	7.12%	58	62.37%	55.25%
Rent	3748	65.06%	22	23.66%	-41.40%
Income	N	%	N	%	
Less than $30,000	995	44.96%	15	24.19%	-20.77%
$30,000-$49,999	586	26.48%	12	19.35%	-7.13%
$50,000-$74,999	416	18.80%	12	19.35%	0.56%
$75,000-$99,999	116	5.24%	9	14.52%	9.27%
$100,000 and up	100	4.52%	14	22.58%	18.06%

Source: 2000 Census

even though apartments only accounted for 31% of the randomly selected addresses. Residents that are renters can move more often and are more difficult to track which may be why the purchased data was incorrect more often for apartments. For ethnicity, according to the Census data, the majority of residents in these blockgroups are Black. While the survey collected 56% Black participants, this is nowhere near the 82% recorded by the Census. In other categories, the survey under-sampled single-person households and the lowest income bracket. Additionally, the two highest income brackets collected more responses than was expected.

CHAPTER V

SUMMARY OF SURVEY RESULTS

This chapter summarizes responses to the questions asked in this survey. The purpose of these summaries is to understand the two populations surveyed as future chapters in this thesis examine the key research questions.

The responses from each survey are presented together and each figure shows the responses in percentages for easy comparison. The responses to each question presented do not include the responses from participants who chose not to answer the question, which is why the total number of responses in each figure may vary. Additionally, any responses submitted by participants younger than the age of eighteen are not included due to IRB restrictions.

Similar to the survey, this chapter is broken up into three sections; ridership habit questions, mapping questions, and demographic questions.

5.1 Ridership Habit Questions

This section is broken up into three subsections: (1) train ridership, (2) bus ridership, and (3) current mode choices.

5.1.1 Train Ridership

For train ridership questions, it is important to keep in mind that all participants in the on-board survey have ridden the train at least once, unlike the mail-home survey, because it was conducted inside the MARTA fare gates in stations and on trains. The following train ridership habits will be examined in this section:

- Train ridership

- How participants typically get to the train
- How participants typically get from the train to their final destination
- The purpose of the majority of train trips
- Why participants use the train
- How participants planned their first MARTA train trip
- How participants planned their trip the day of the survey/typically plan train trips

Figure 21 shows the train ridership for all participants in both surveys. There are clear differences between the survey, as there are significantly more frequent train riders in the on-board survey. It is important to keep in mind that these two samples came from different populations . The on-board survey is from the population of all train-riders while the mail-home survey is from all residents of the selected neighborhoods.

Figure 22 summarizes how participants in both surveys typically get to the train and how participants typically get from the train to their final destination. The majority of participants access the train and final destination via walking, driving car, and by taking the bus. The high numbers of participants accessing the train via bus is indicative of the bus system serving as a feeder system for the train lines and why there were no bus-only riders captured in this survey.

For the typical train trip purpose, there was a difference between the two surveys. In the on-board survey, the majority of participants stated that their typical purpose was work, while in the mail-home survey it is evenly spread between work, social/recreational, shopping, special events, and the airport.

This, again, is tied to the fact that they came from different samples. Those who take the train for work are taking it more frequently, and there are more of these

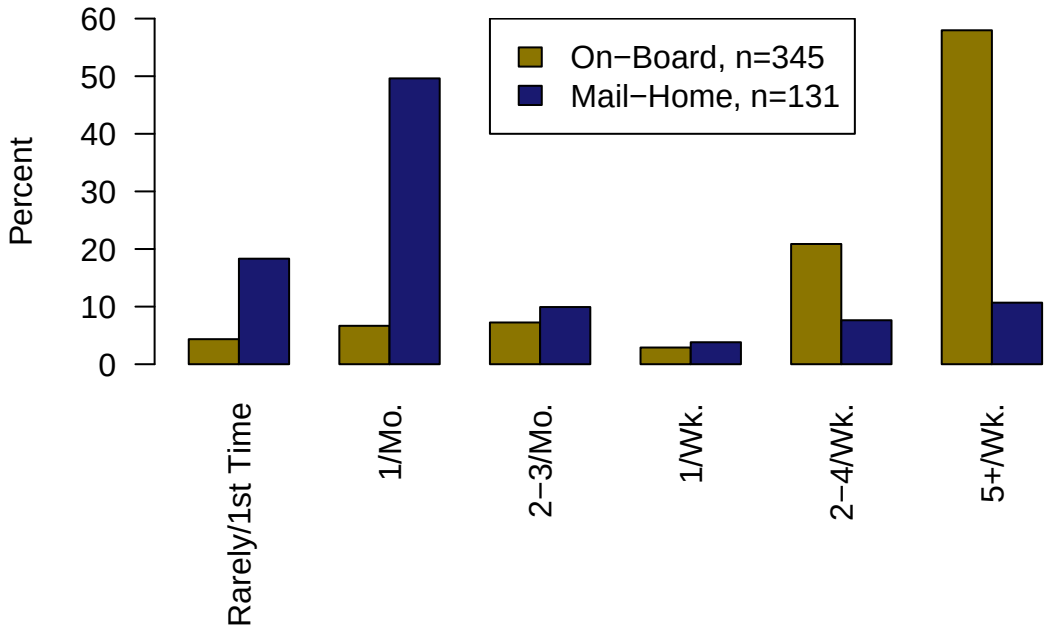
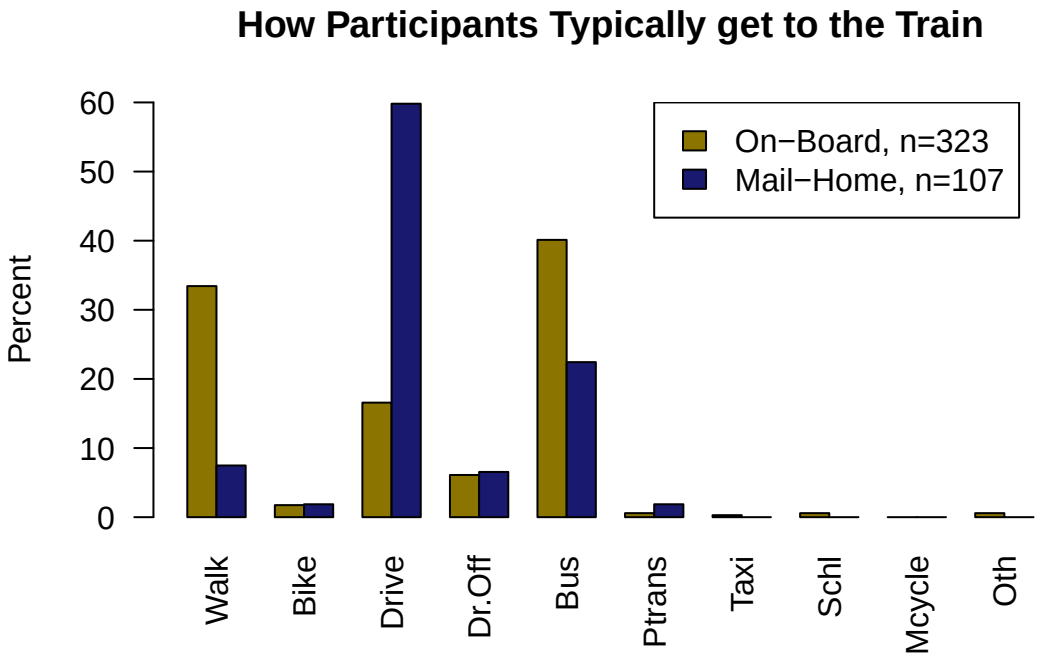


Figure 21: Summary: Train Ridership

types of participants in the on-board survey. On the other hand, participants in the mail-home survey tend to take the train less often for non-regular trip purposes.

All participants in the on-board survey and those who indicated that they do ride the train in the mail-home survey were asked why they take it. They were given the following possible responses:

- It is cheaper than driving (CHEAP)
- It is easy to get to (EASY)
- The train is faster than driving (FAST)
- It is greener than driving (GREEN)
- I do not have access to a car (NOCAR)
- It is less stressful and I can avoid traffic (STRESS)



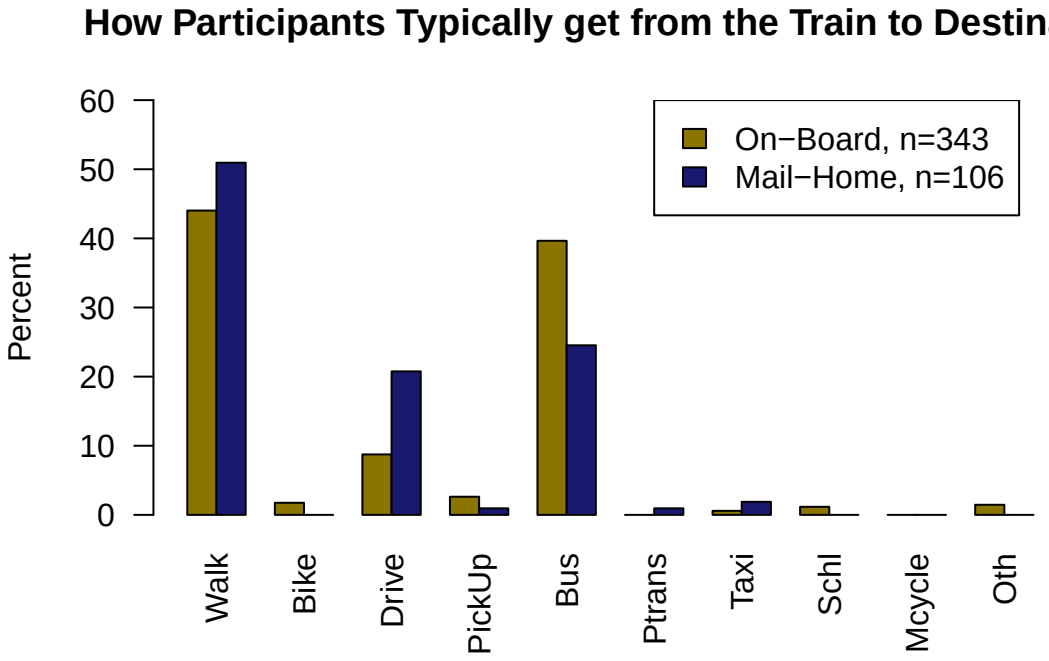


Figure 22: Summary: Train Access

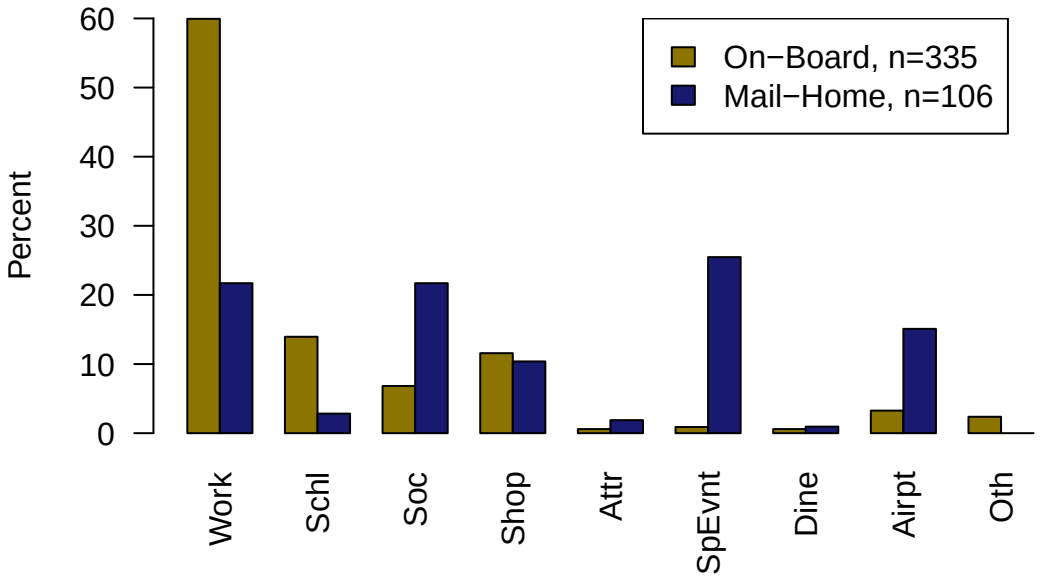


Figure 23: Summary: Purpose of the Majority of Train Trips

- Other (OTH)

The responses to this question, seen in Figure 24, were similar in each survey except the percentage of participants that responded that they took the train because they do not have access to a car and those that stated they take it to avoid traffic and stress. The percentages for these two responses are approximately reversed in the two surveys, with more in the on-board survey taking the train because they have no car and more participants taking it to avoid traffic in the mail-home survey.

Participants were asked how they planned both their first train trip and either how they planned it the day of the survey (on-board survey) or how they typically plan train trips (mail-home survey). The possible answers provided in the survey included the following:

- Smartphone application (APP)

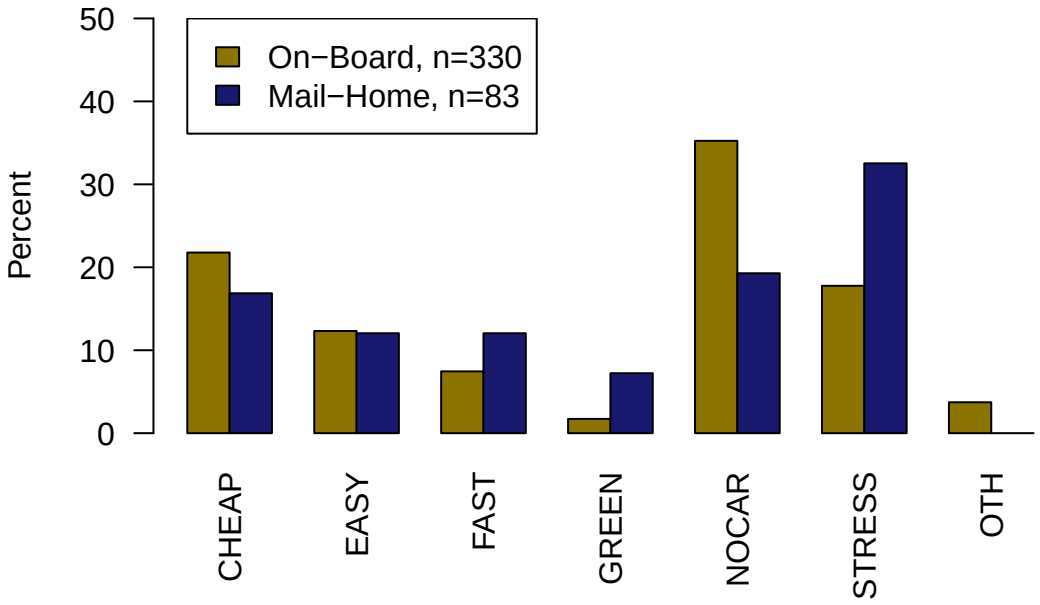


Figure 24: Summary: Reasons Why Participants Take the Train

- Paper maps and schedules (PAPER)
- Calling MARTA's information number about arrival times (PHONE)
- An online trip planner (TP)
- Online maps and schedules (WEB)
- Help from a friend or family member (WORD)
- Other (OTH)

Figure 25 shows for both surveys how participants planned their first train trip and how they typically plan their train trips now. Both surveys have similar results for planning their first trip, but differ in how they now typically plan their trips. In the on-board survey, so many participants selected "Other" and said that they simply know where to go because they have made the trip so many times and are familiar

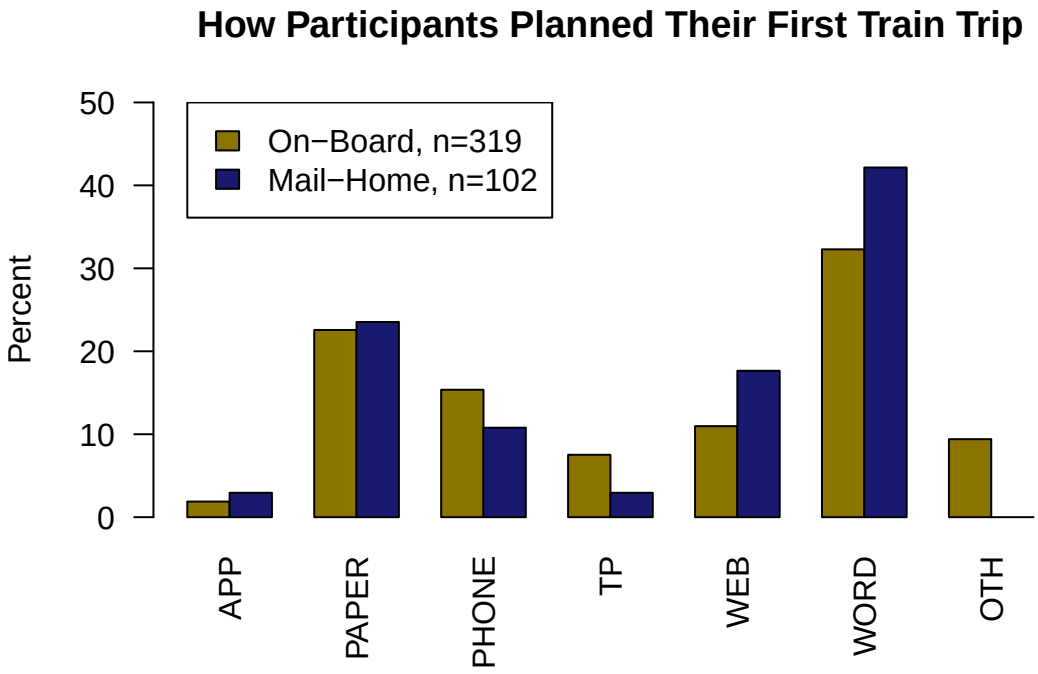
with the system that it was added as a category for the on-board survey. In the mail-home survey many more participants use the Internet or asking another person where to go. It is interesting to note that in the mail-home survey, approximately the same percentage of participants stated that they planned their first trip and still typically plan their trips with paper maps, indicating that it is still important to provide helpful and informative paper maps in stations and on transit vehicles.

5.1.2 Bus Ridership

Unlike the question of train ridership, in both surveys there were participants who responded that they do not ride the bus at all. For this reason, the number of participants responding to each question is much lower than the total number of participants in each survey. In this section, the following train ridership habits will be summarized:

- Bus ridership
- How participants typically get to the bus
- The purpose of the majority of bus trips
- Why participants use the bus
- How participants planned their first train trip
- How participants would plan a bus trip

Examining Figure 26 there are distinct differences between the ridership habits of the two samples. In the on-board survey the majority of participants either were riding MARTA for the first time or rarely or ride it almost every day. In the mail-home survey, the most popular category was "Never/Rarely". Similar to the on-board survey, the smallest category was the occasional riders.



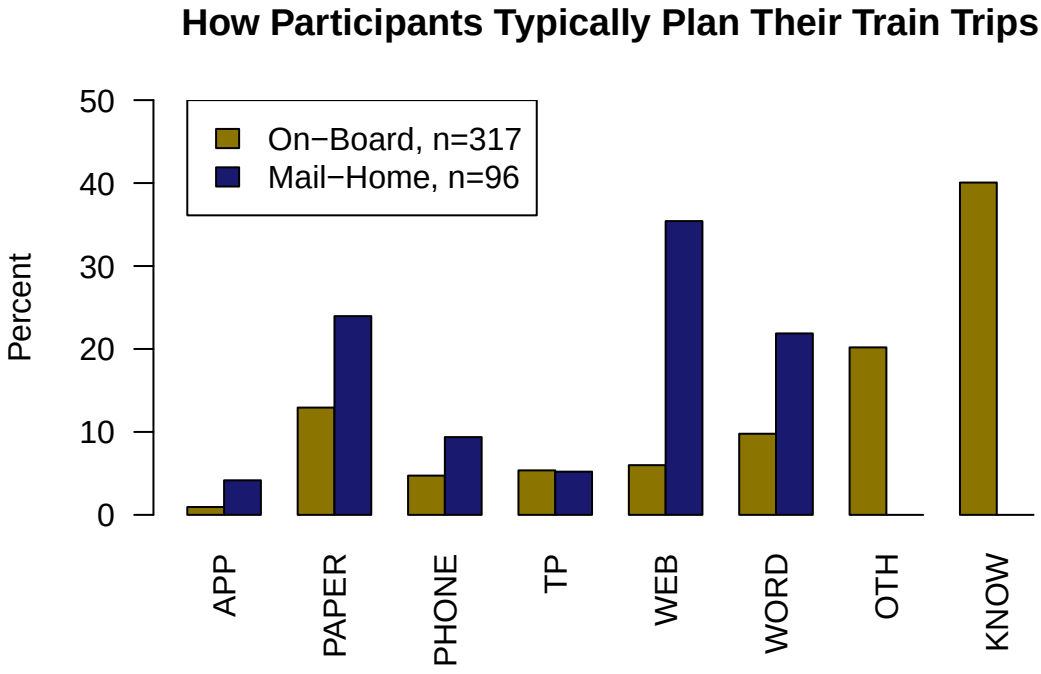


Figure 25: Summary: Train Trip Planning

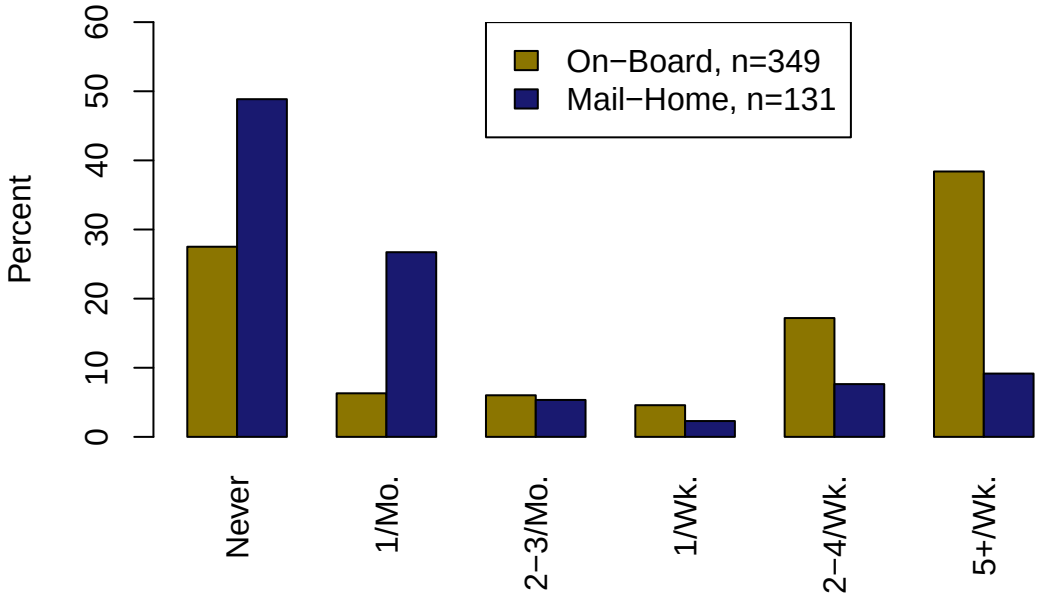


Figure 26: Summary: Bus Ridership

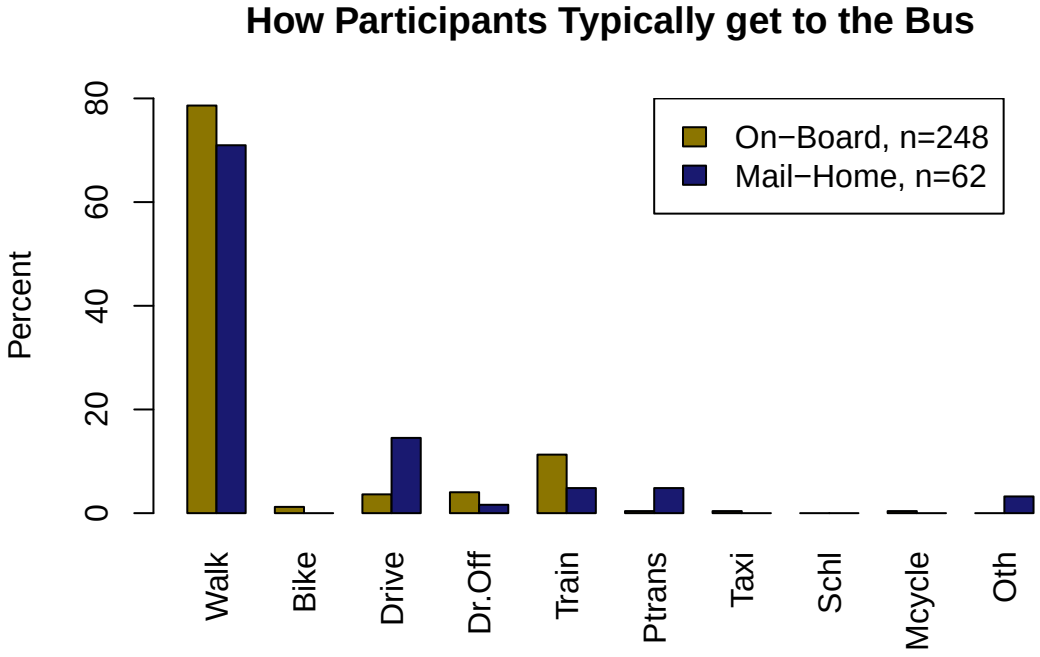


Figure 27: Summary: Bus Access

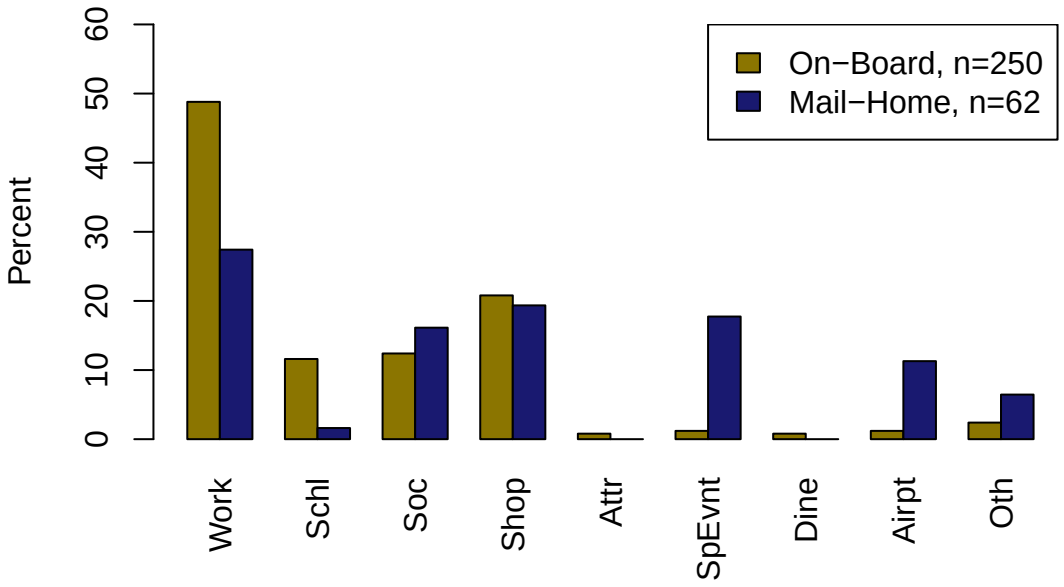


Figure 28: Summary: Purpose of the Majority of Bus Trips

In both surveys, a large majority access the bus via walking. This is expected, these are local bus routes and stop generally at every block and also have no available parking for people to drive to the bus. This can be seen in Figure 27.

The recorded bus trip purposes are similar to those for train ridership as seen in Figure 28. This could be because some trips require a bus and a train to get to, however, this was not asked in the survey. In the on-board survey, almost half of the participants stated that they take the bus for work, while that number was lower in the mail-home survey. It is interesting to note that in both surveys, the percentage of participants that take the bus for shopping/errands is greater than it is in train trip purpose.

The responses for reasons why participants who do take the bus ride it can be seen in Figure 29. For reasons why participants take the bus, participants were

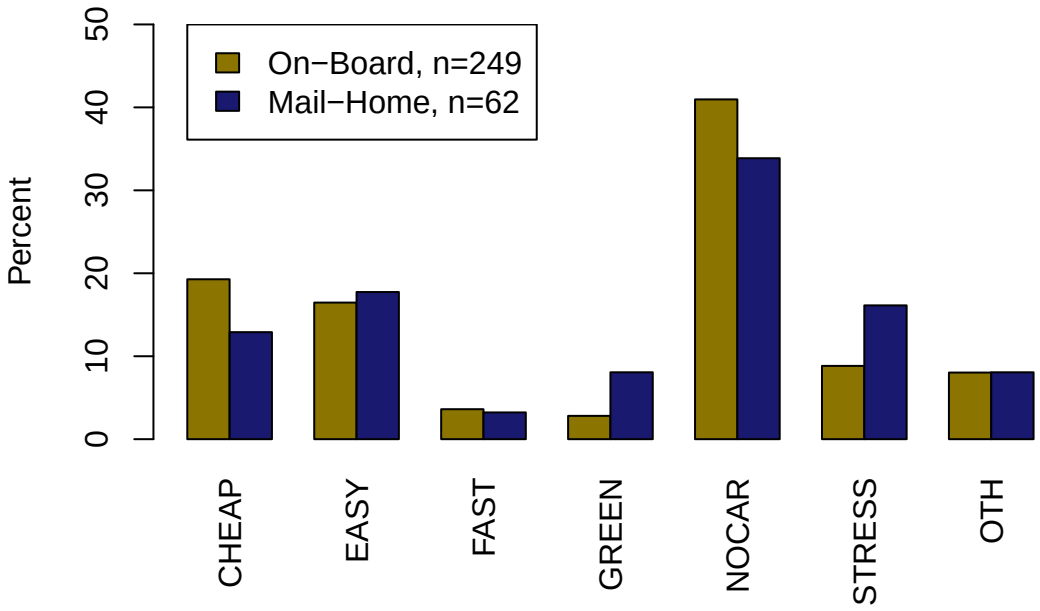


Figure 29: Summary: Reasons Why Participants Take the Bus

presented with the same possible answers that were supplied when asking why participants take the train. The responses are similar to those of why participants take the train, however there are fewer responses indicating that the reason is to avoid traffic. This is understandable as these local buses can also be stuck in traffic along with personal vehicles.

When asked how they would plan a bus trip, participants were provided with the same possible answers as those used when asking how they plan train trips. In Figure 30, there is a similar distribution for how participants would plan a bus trip. In both surveys, paper maps were the most popular answer. While the responses were different for train trip planning, this speaks to the importance of this thesis because paper maps are important, especially when planning a bus trip in Atlanta.

Participants who responded that they do not ride the bus were asked why. They were provided with the following possible answers:

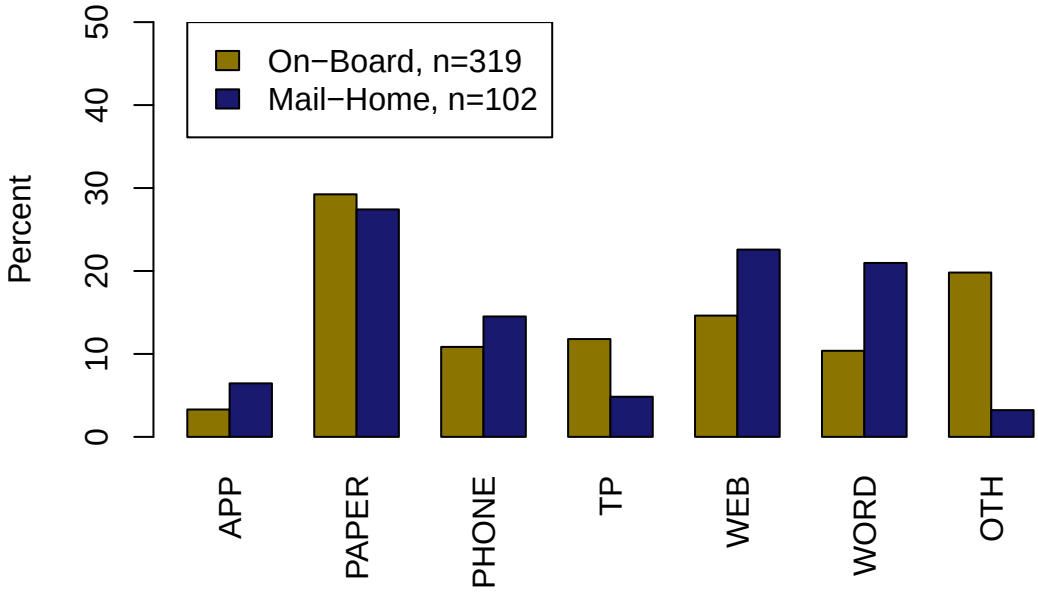


Figure 30: Summary: Bus Trip Planning

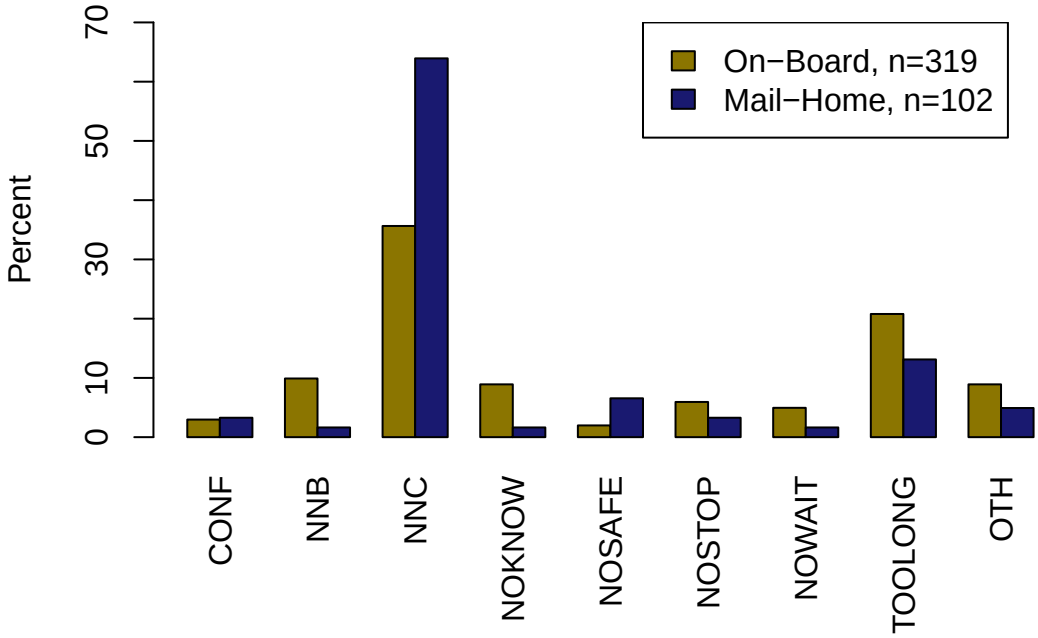


Figure 31: Summary: Why Participants Do Not Take the Bus

- The information about routes and schedules is confusing (CONF)
- You don't like waiting for the bus if it is late (NOWAIT)
- You do not know when the bus is coming (NOKNOW)
- The bus takes too long (TOOLONG)
- You do not feel safe on the bus (NOSAFE)
- There is not a bus stop near you (NOSTOP)
- You don't need a bus because you can walk or bike (NNB)
- You don't need a bus because you can drive (NNC)
- Other (OTH)

In both surveys, the most popular answer was that they did not need to take the bus because they had access to a car, as seen in Figure 31. The second most popular reason was that the bus takes too long.

5.1.3 Current Modes

This section includes the responses of how participants travel the most and which transit modes they currently use. The latter is a combination of participants' responses to train and bus ridership. This categorizes participants as train-only riders, both train- and bus-riders, and non-transit riders. As previously mentioned, there were no bus-only riders captured in this survey.

In the on-board survey, the highest modes that participants utilize the most are driving (33.3%), and taking the train (30.2%), while the large majority of participants in the mail-home survey (75.2%) drive the most as seen in Figure 32. The results speak to how the populations are different and how there are significantly more frequent

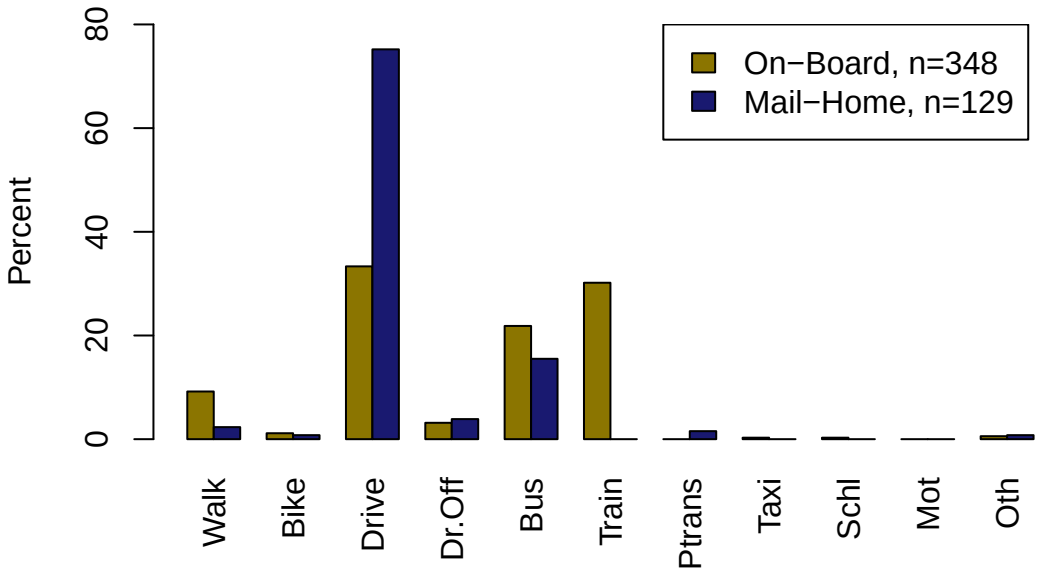


Figure 32: Summary: How Participants Travel the Most

train riders in the on-board survey. It is interesting to note that no one in the mail-home survey uses the train as their primary mode of transportation. However, this is not unreasonable because these participants do not live within walking distance of a train station and the train stations that are close have limited parking available.

Figure 33 shows which transit modes participants currently use. As mentioned previously, there are no non-transit riders in the on-board survey, as all participants in this survey take the train either rarely, occasionally, or frequently. About half (51.1%) of participants in the mail-home survey are train-only riders. This category includes only transit modes that participants currently use. A train-only rider is someone who takes the train, but not the bus.

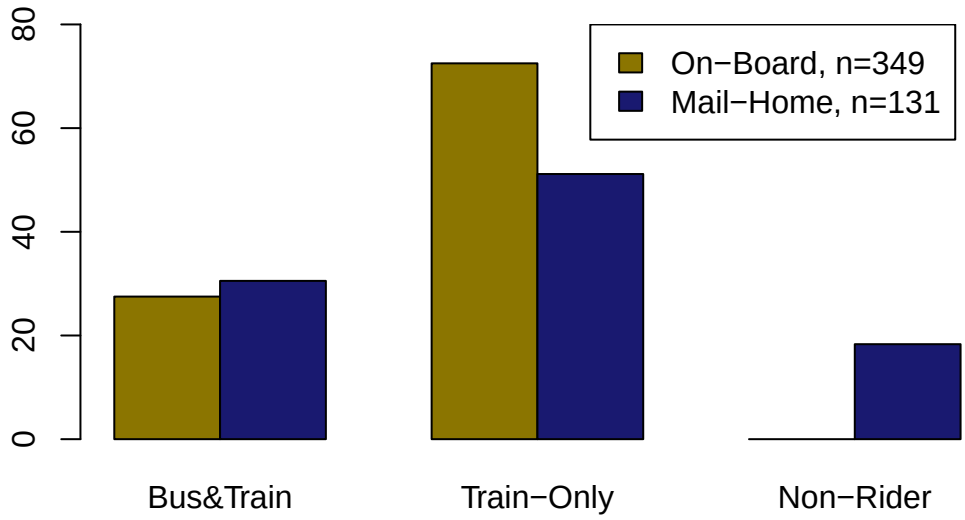


Figure 33: Summary:Current Transit Modes

5.2 Mapping Questions

The questions in the mapping section are how participants responded to the multi-modal maps they were presented with. Some of these questions will be examined in greater detail in the following three chapters. The questions that will be summarized in this section are:

- Whether participants thought routes that reach popular destination are more important or routes with frequent service
- Which map was the easiest to read
- Which map was the most useful
- Whether participants would ride the bus more if one of these maps was implemented

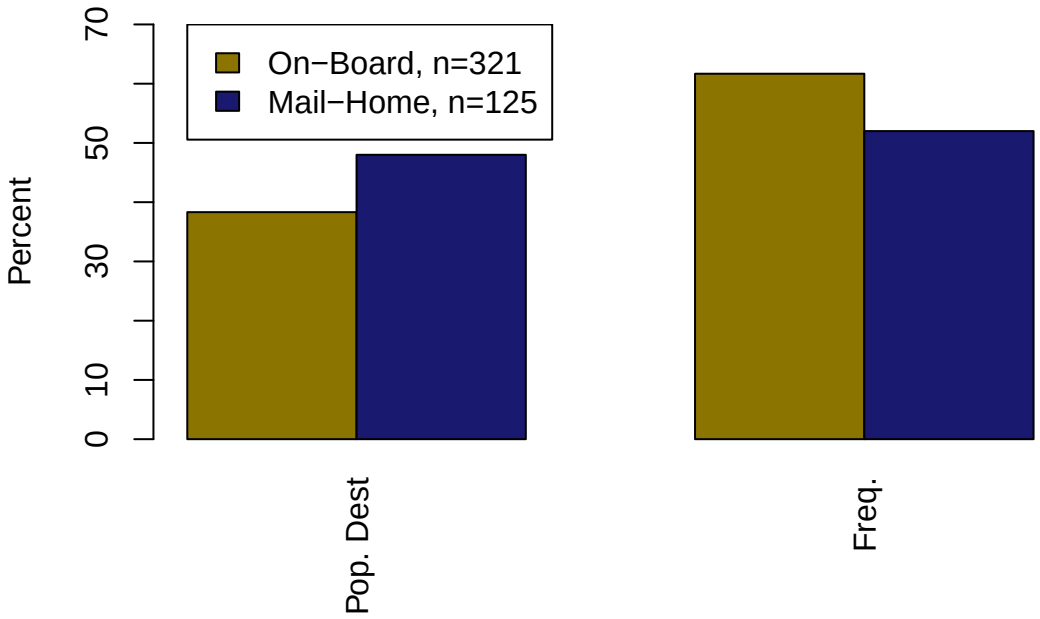


Figure 34: Summary: Popular Destinations vs. Frequency

- Whether participants would understand the overall MARTA system more if one of these maps was implemented

In both surveys, riders stated that including frequency in these multi-modal maps was more important than including routes that reach popular destinations, however there was a larger difference in the on-board survey than in the mail-home survey, as seen in Figure 34. The responses to this question will be explored further in Chapter 6.

Despite the fact that participants thought that frequency was more important, participants in both surveys selected the popular destinations map as the most useful in Figure 35. This will also be examined further in the next chapter, indicating that this may not be only a map design issue but a network design one.

The ranking of which map was the easiest to read was different in both surveys, as shown in Figure 36. In the on-board survey, the majority of participants thought

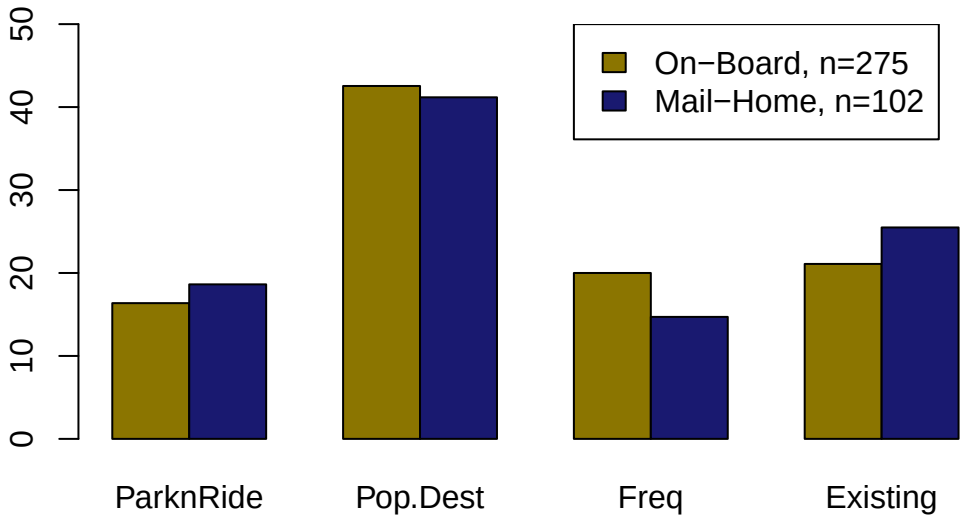


Figure 35: Summary: Most Useful Map

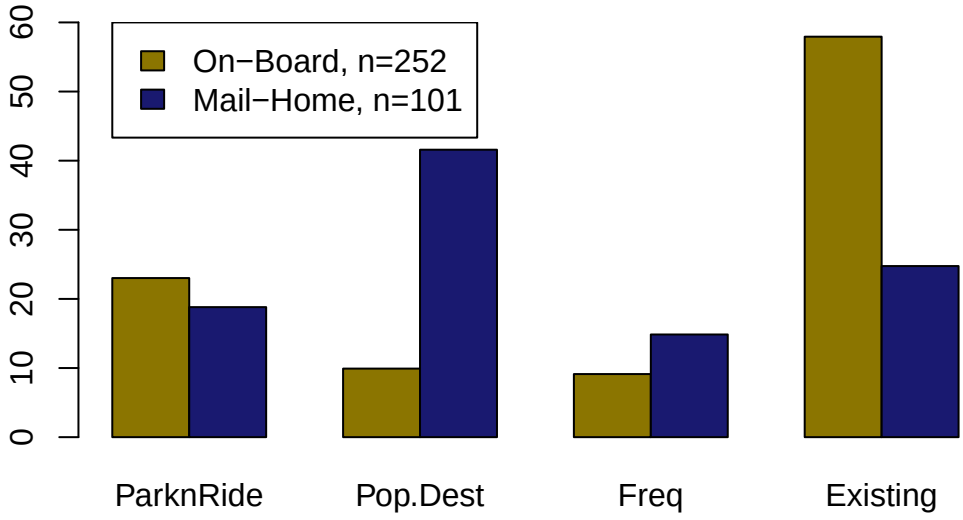


Figure 36: Summary: Easiest Map to Read

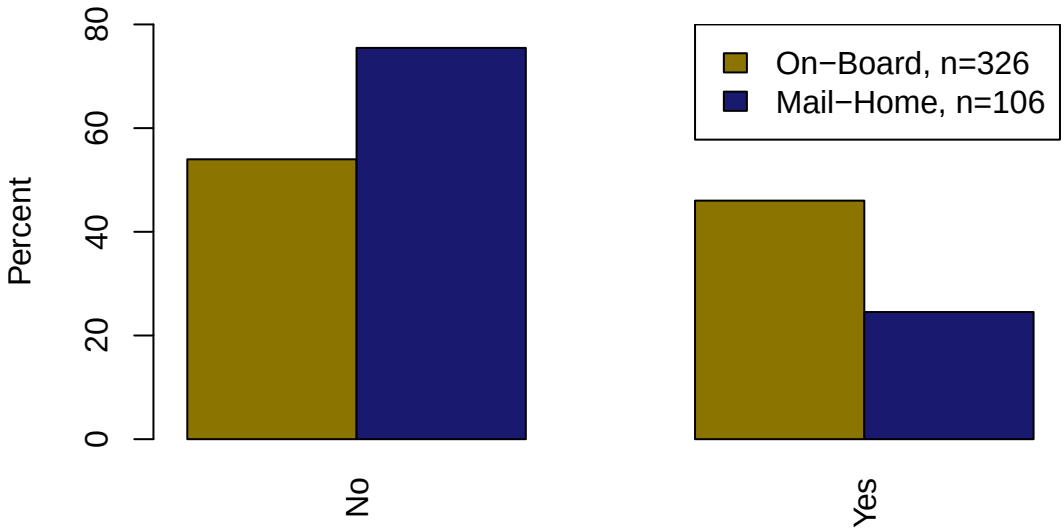


Figure 37: Summary: Whether Participants Would Ride the Bus More

that the existing MARTA map was the easiest to read, which makes sense because it is the simplest map that was shown to participants. In the mail-home survey, results were much different. The distribution was the same as the most useful map, and there were many participants that ranked the maps in the same order for most useful and easiest to read. Perhaps some participants were confused about the difference in the ranking questions.

Figure 37 summarizes whether participants stated that they would ride the bus more in the future if these maps were implemented. More participants in the on-board survey stated that they would ride the bus more. This question will be further examined in Chapter Seven. Chapter Eight will go on to further analyze whether participants would understand the overall MARTA system map more if these maps were in place. Figure 38 summarizes the responses. In this case, both surveys responded with almost identical percents responding "yes" or "no".

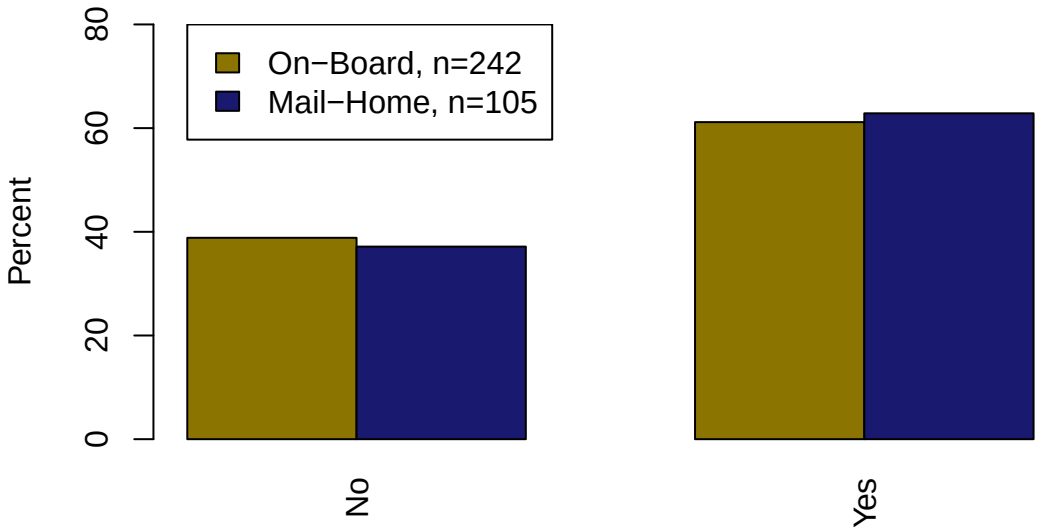


Figure 38: Summary: Whether Participants Would Understand the System More

5.3 Demographic Questions

These questions were asked to get a picture of the participants and characteristics that may affect their transportation choices. Participants were not required to answer these questions, which is why the number of responses in each survey to these questions varies and is lower than those in the ridership habits and mapping questions. The demographic questions that were asked of each participant were the following:

- Household Vehicles
- Gender
- Marital Status
- Household Structure
- Licensure

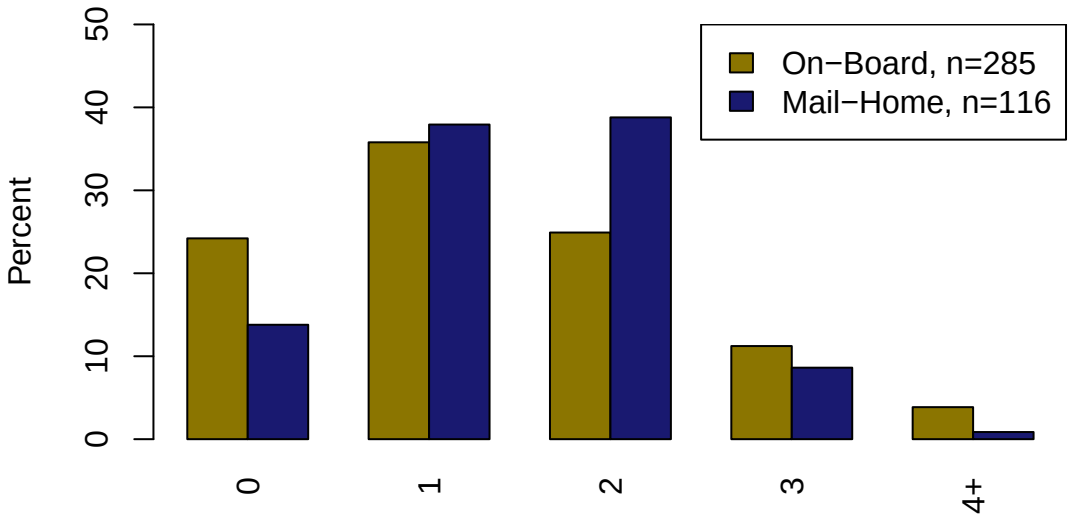


Figure 39: Summary: Household Vehicles

- Ethnicity
- Household Tenure
- Education
- Income

Figure 39 shows the distributions for the number of household vehicles for each participant in the two surveys. The main differences between the two surveys were that the on-board survey had more participants with zero household vehicles and fewer households with two vehicles.

Figures 40 and 41 show the breakdown of gender and marital status for the two surveys. The on-board survey had more males and more single participants than the mail-home survey.

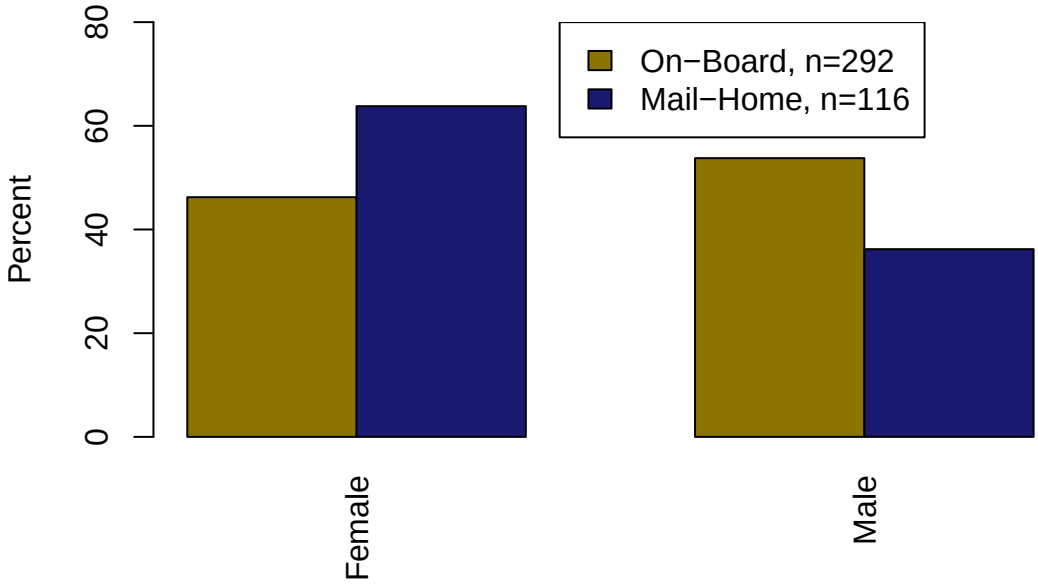


Figure 40: Summary: Gender

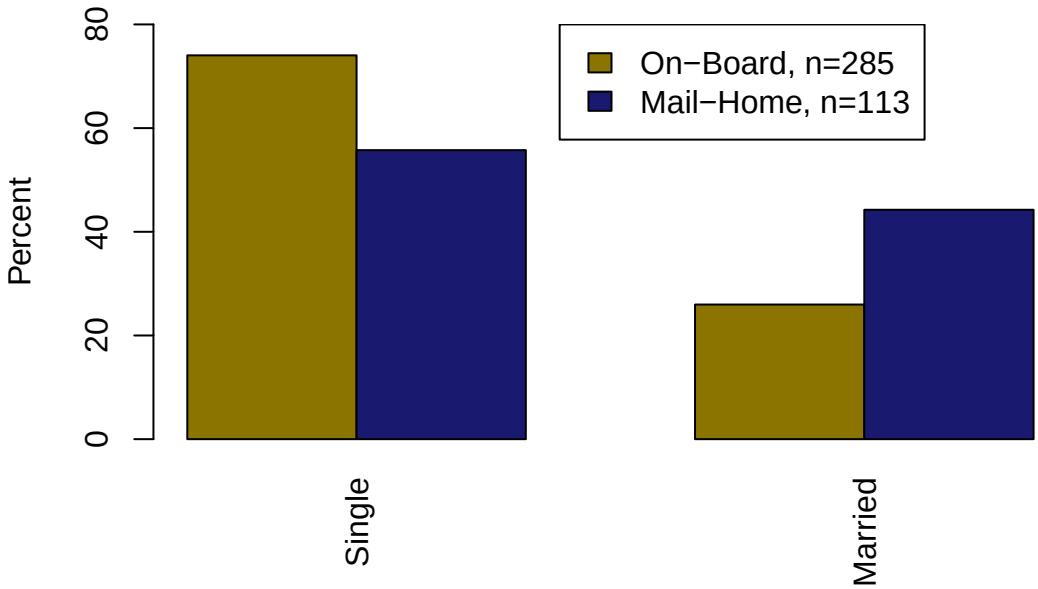


Figure 41: Summary: Marital Status

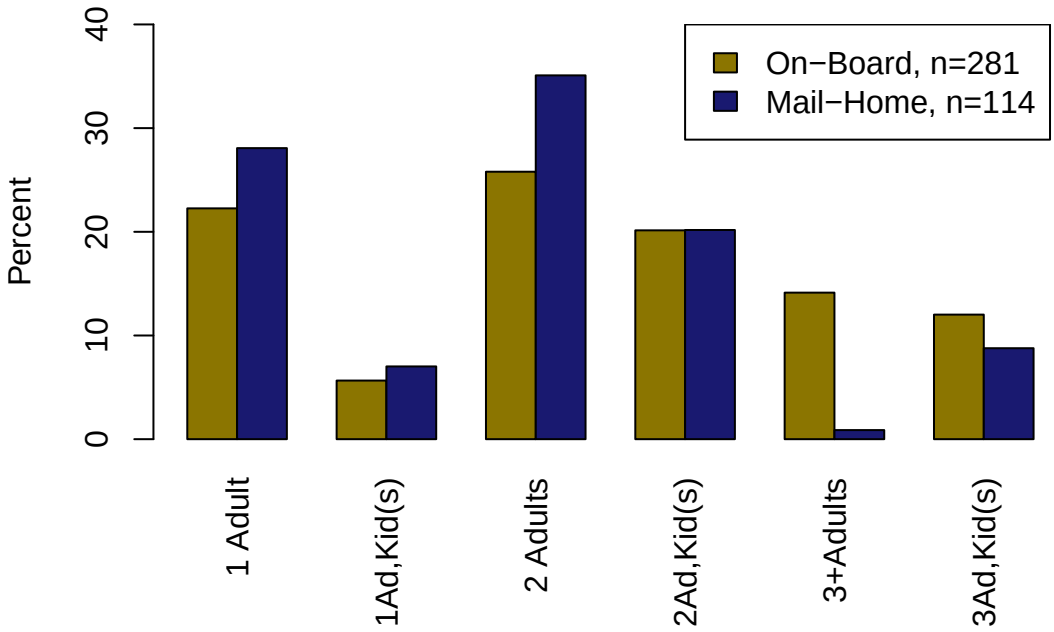


Figure 42: Summary: Family Structure

Family structure was not a question in the survey. Each participant was asked how many adults and children were in their household and the resulting answers together created this family structure distribution. Figure 42 shows the comparison of family structure for the two surveys. The main difference was in households with three adults and no children. There was a very small number of participants in this type of household in the mail-home survey.

In both surveys, the large majority of participants had their driver's license, as seen in Figure 43. This might not be quite representative of the whole populations because people under eighteen were left out and although they may not have obtained their license yet, they still need to get around to school and various other activities.

With regards to ethnicity, Black, White, and Asian were the only ethnicities that had enough responses to stand on their own, as seen in Figure 44. In future chapters, ethnicity will be reduced to these three categories with the rest combined

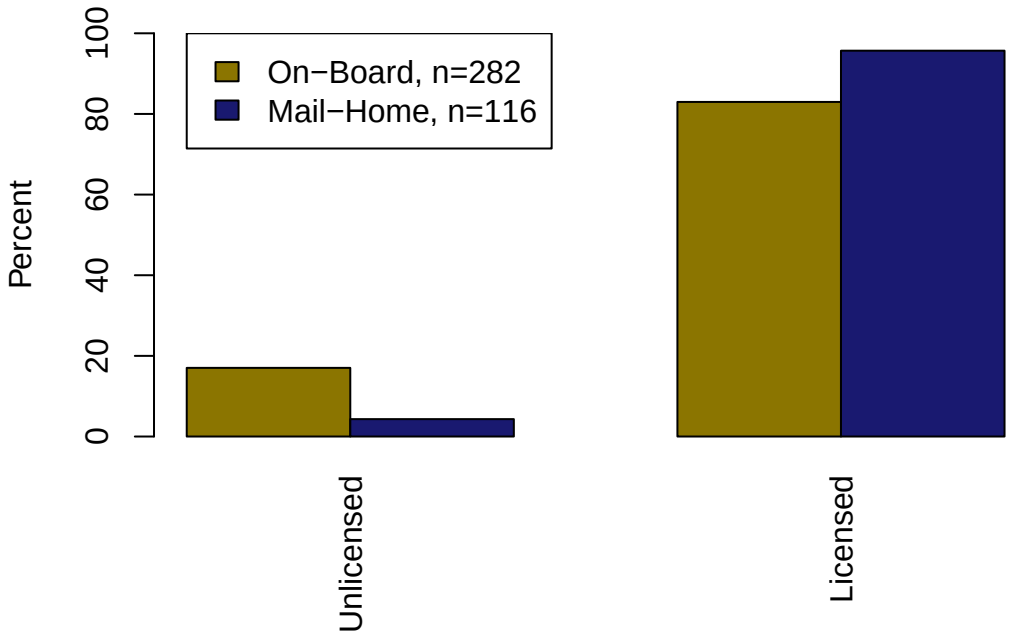


Figure 43: Summary: Participant Licensure

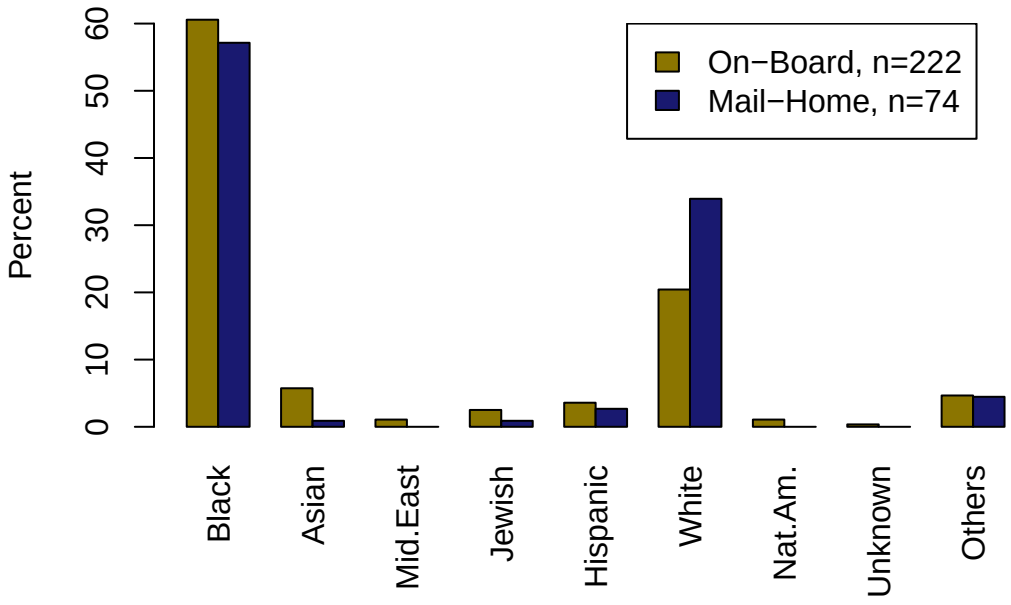


Figure 44: Summary: Participant Ethnicity

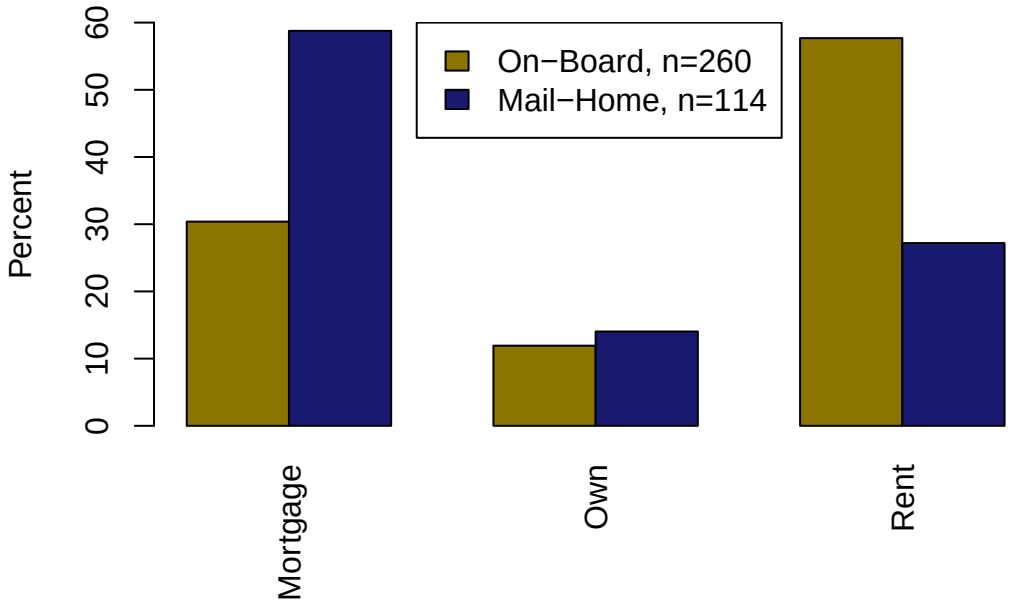


Figure 45: Summary: Tenure

into one "Other" category.

The tenure category was very different between the two distributions, as seen in Figure 45. In the on-board survey, the majority of participants are renters and in the mail-home survey the majority of participants own their homes with mortgages. This may have something to do with the mailing addresses that were purchased, as discussed in Chapter Four.

In the comparison with education, there were similar results in each survey. The main differences that can be seen in Figure 46 are those with a high school diploma and those with graduate degrees. The on-board survey had more participants whose highest education level was a high school diploma and the mail-home survey had more participants who have a graduate degree. Finally, the income distribution was similar in both surveys, as seen in Figure 47.

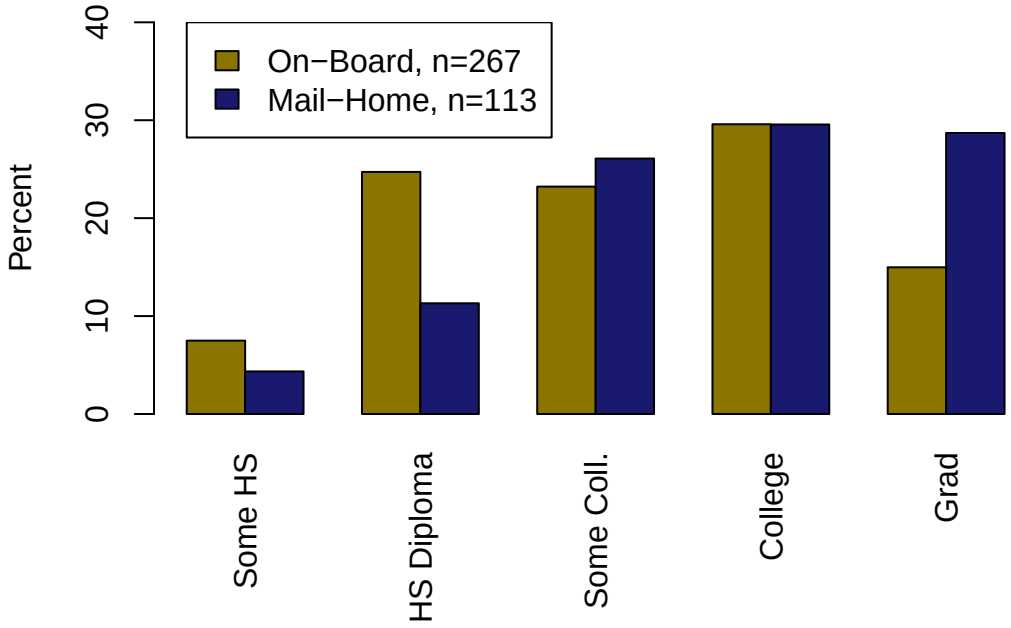


Figure 46: Summary: Participant Education

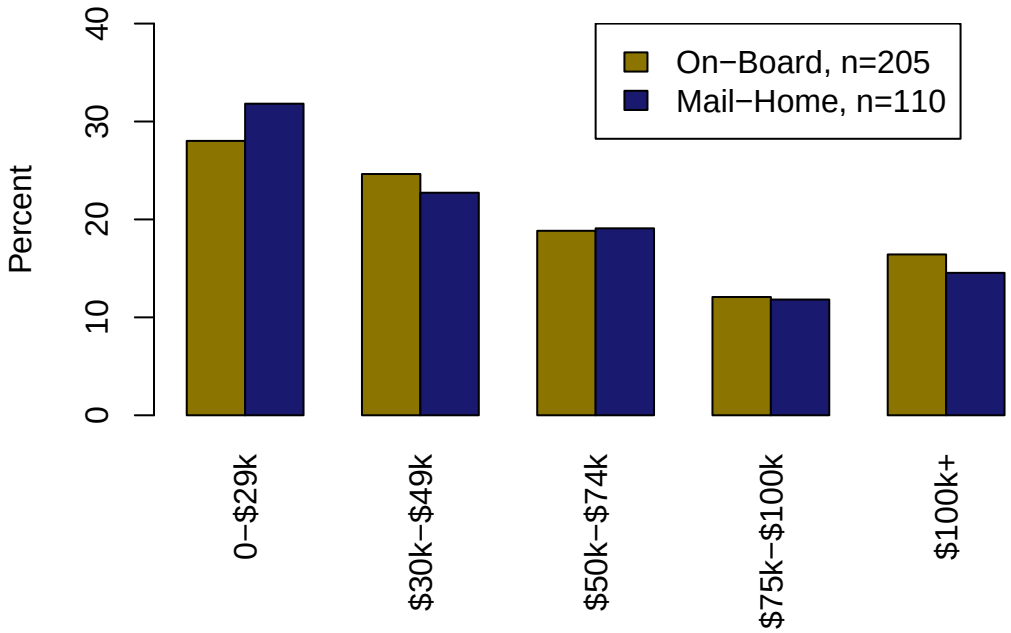


Figure 47: Summary: Annual Household Income

Overall, the main differences between the two surveys are train ridership, train trip purpose, bus ridership, easiest map to read, and tenure. The questions regarding popular destinations versus frequency, future bus ridership, and future understanding will be examined in detail in the following three chapters. Attention will also be paid to the fact that the majority of participants thought that frequency was more important, yet the popular destinations map was ranked as the most useful.

CHAPTER VI

ANALYSIS AND RESULTS: POPULAR DESTINATIONS VS. FREQUENT SERVICE

This chapter presents the analysis and results for both the on-board and mail-home surveys for the question:

Is it more important for maps to include bus and train routes that reach popular destinations or that come more often?

This question is important because it strikes at the core of what riders want to see on their maps and what impacts their travel decisions, possible desitinations or any locations that are conveniently accessible by frequent service.

In this chapter as well as the following two, the responses and results of the two surveys will be statistically analyzed in the same way and compared. For each survey, responses to the question of popular destinations versus frequency and the following questions will be statistically tested using a chi-square test.

- Train Ridership and Trip Purpose
- Bus Ridership and Trip Purpose
- Current Transportation Mode Choices
- Most Useful Map
- Licensure
- Household Vehicles
- Ethnicity

- Income
- Household Structure

A total of 349 surveys were collected in the on-board survey. After excluding the responses from participants under eighteen and the participants that did not answer this question for various reasons, 321 responses were used in the analysis for this chapter.

For the mail-home survey, 138 responses were recorded. Similarly, incomplete responses for this question were excluded only for the analysis in this chapter, which brought the mail-home survey total to 125 for this question. Figure 48 summarizes the responses to the question of popular destinations or frequent service for each survey. The purple indicates those participants selected popular destinations and light pink indicates frequent service. The same purple and pink colors will be used throughout the chapter. Based on raw percentages, frequent service is preferred 62% of the time in the on-board survey, but in the mail-home survey, only 52% preferred it. Through comparative analysis, this chapter will go on to examine who it is in this survey that desires frequent service on the maps and who desires popular destinations.

6.1 Train Ridership and Trip Purpose

Asking participants how often they currently use the train and for what purpose is important in understanding how they use the train and how these maps could affect them. In the on-board survey, all participants had ridden a MARTA train at least once, but in the mail-home survey, some participants had not. The ridership responses and whether participants selected popular destinations or frequency as more important were tested using a chi-square test. Current train ridership for the responses to each survey and their corresponding chi-square test p-values are summarized in Tables 12 and 13.

For all statistical tests in this chapter, an alpha value of 0.05 was used. For the

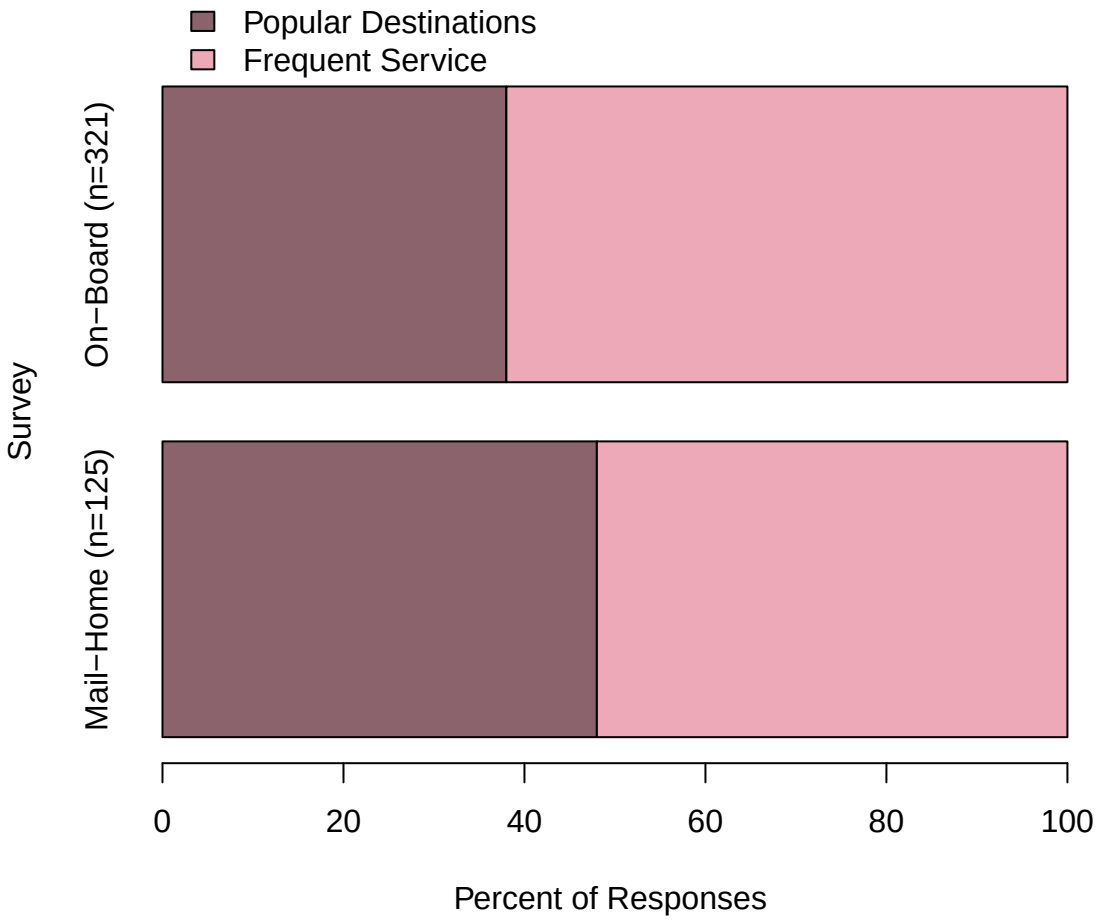


Figure 48: Summary: Popular Destinations vs. Frequent Service

on-board survey, the chi-square test produced a p-value less than alpha, indicating that participants answered differently based on their reported train ridership. To calculate the p-value, the categories "two to three times per month" and "once per week" were combined in the on-board survey. In the mail-home survey, the six categories were reduced to three because of the lack of responses in certain categories. For the chi-square to be the most accurate, it is important to not have less than five responses in each possible category.

Examining Tables 12 and 13, participants who rode between once each month and once each week in the on-board survey tended to select popular destinations while

Table 12: On-Board Survey: Popular Destinations/Frequent Service vs. Reported Train Ridership

n = 316						
	Rarely	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Popular Destinations	5	13	12	7	22	63
Frequent Service	9	7	12	1	46	120

Table 13: Mail-Home Survey: Popular Destinations/Frequent Service vs. Reported Train Ridership

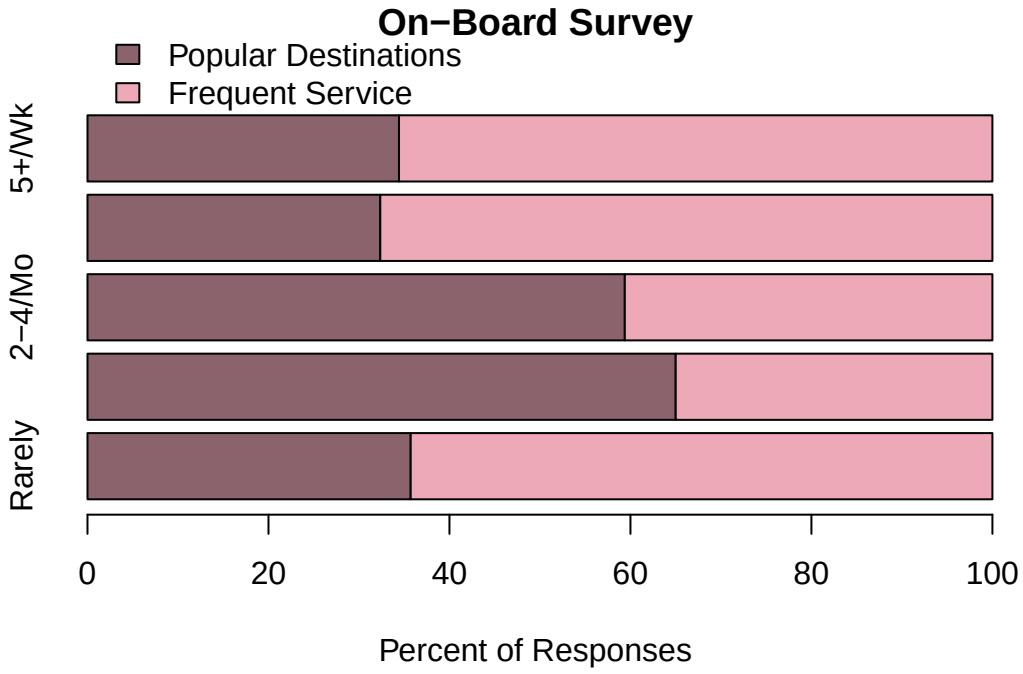
n = 125						
	Never	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Popular Destinations	9	33	4	2	5	7
Frequent Service	11	31	9	2	5	7

those who rarely and often rode tended to select frequency as more important and there is no trend in the mail-home survey, as illustrated in Figure 49. This figure shows the percent of each responses for how each ridership category responded to this question so that each group is easily comparable.

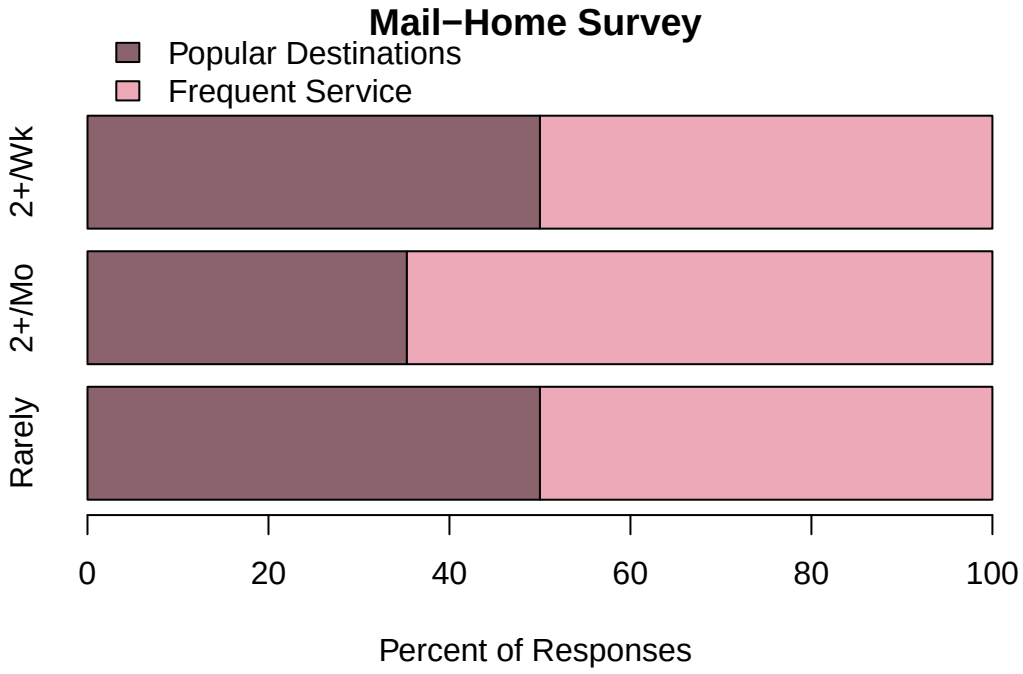
The fact that train ridership is significant in the on-board survey may also have to do with the purpose of their train trips. It could be that those who never ride the train do not do so because of frequency and that those who only take it occasionally only take trains for a specific purpose and want to be able to take it to popular destinations.

When participants were asked what the purpose of their train trips were, the following were possible responses (and abbreviations) in the multiple choice question:

- Work/Commuting (Work)
- School/College (Schl)
- Recreational/Social (Rec/Soc)
- Errands/Shopping (Shop)
- Tourist Attractions (Attr)



p-value = 0.0038



p-value=0.53

Figure 49: Popular Destinations/Frequent Service vs. Train Ridership

- Special Event (SpEvnt)
- Dining Out (Dine)
- Airport (Air)
- Other (Oth)

These abbreviations will be used in all tables and figures referencing the train or bus trip purpose in this chapter as well as the following two.

Both "Dining Out" and "Tourist Attractions" had fewer than five responses so they were included in the "Other" category. The responses to typical train trip purpose can be seen for the on-board and mail-home surveys in Tables 14 and 15 respectively.

Examining these tables, train trip purpose was significant for the on-board survey, but not the mail-home survey. The purposes that tended to select frequency in the on-board survey were regular trips such as commuting, school, and errands/shopping. On the other hand, participants in the on-board survey with train trip purposes that were occasional tended to select popular destinations. Train trip purpose was not significant for the mail-home survey.

Table 14: On-Board Survey: Popular Destinations/Frequent Service vs. Train Trip Purposes

n = 310							
	Work	Schl	Rec/Soc	Shop	SpEvnt	Air	Oth
Popular Destinations	63	17	16	12	2	8	3
Frequent Service	124	25	7	24	1	2	6

Table 15: Mail-Home Survey: Popular Destinations/Frequent Service vs. Train Trip Purpose

n = 102							
	Work	Schl	Rec/Soc	Shop	SpEvnt	Air	Oth
Popular Destinations	13	0	10	6	13	9	0
Frequent Service	10	2	13	4	14	7	3

For the chi-square test of the on-board survey, the "Special Event" category was combined with the "Other" category because of low response numbers. For the mail-home survey, "Work/Commuting" and "School/Commuting" were combined and "Shopping/Errands" were included in the "Other" category.

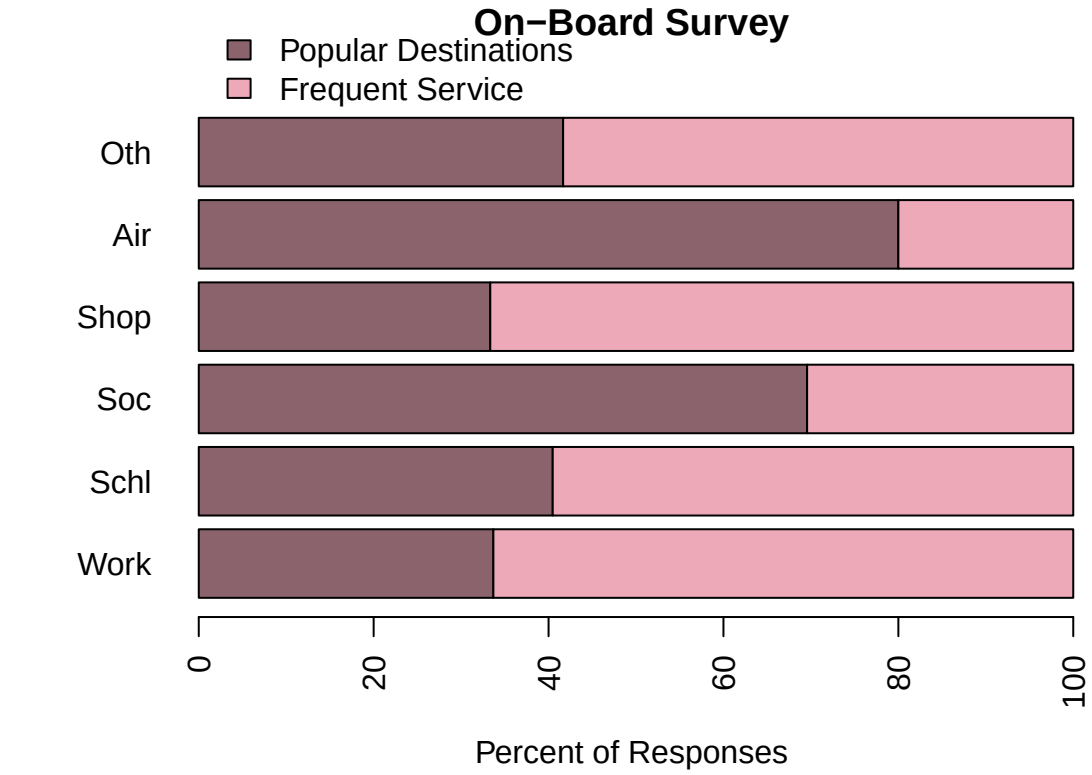
Train riders in the on-board survey whose purpose was the airport, special events, or recreational/social trips were more inclined to respond that popular destinations on the maps were more important. On the other hand, those who rode the train on more regular trips such as work, school, and shopping, and attractions were more inclined to respond that frequent service was more important. Train trip purpose was not significant for the mail-home survey.

6.2 Bus Ridership and Trip Purpose

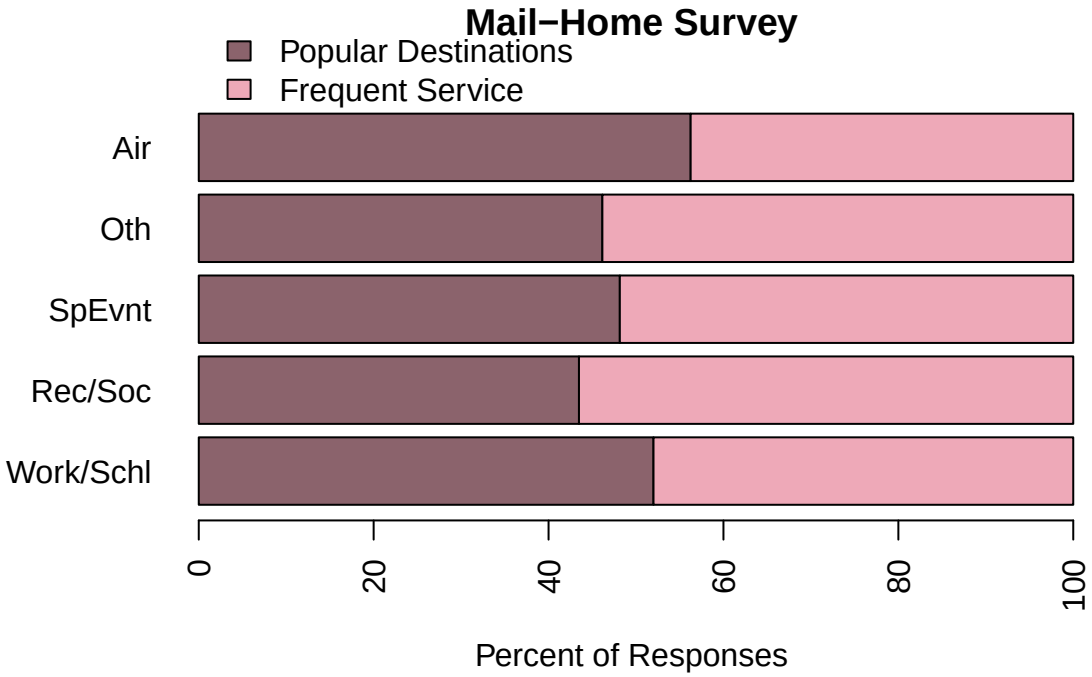
Bus ridership is also an important variable to compare to so that we can understand what participants with different bus ridership habits would like to see in these system maps. Tables 16 and 17 summarize the responses to this question. To calculate the p-value, the mail-home survey, combines the different levels of ridership into three categories (once per month or less, two times per month up to once per week, and several times a week or more) because of the low number of participants and very few responses in some categories. For both surveys, due to lack of responses, the categories "two to three times per month" and "once per week" were combined.

Based on Tables 16 and 17, there seems to be a trend in the on-board survey but none in the mail-home survey. Figure 51 shows these combined categories and calculated p-values. Here, the frequent bus riders from the on-board survey chose frequent service, while occasional and non-riders were split between frequent service and popular destinations. Bus ridership was not significant in the mail-home survey.

As with train trip purpose, bus trip purpose was also analyzed with the same list of possible responses. Tables 18 and 19 show the bus trip purposes and whether

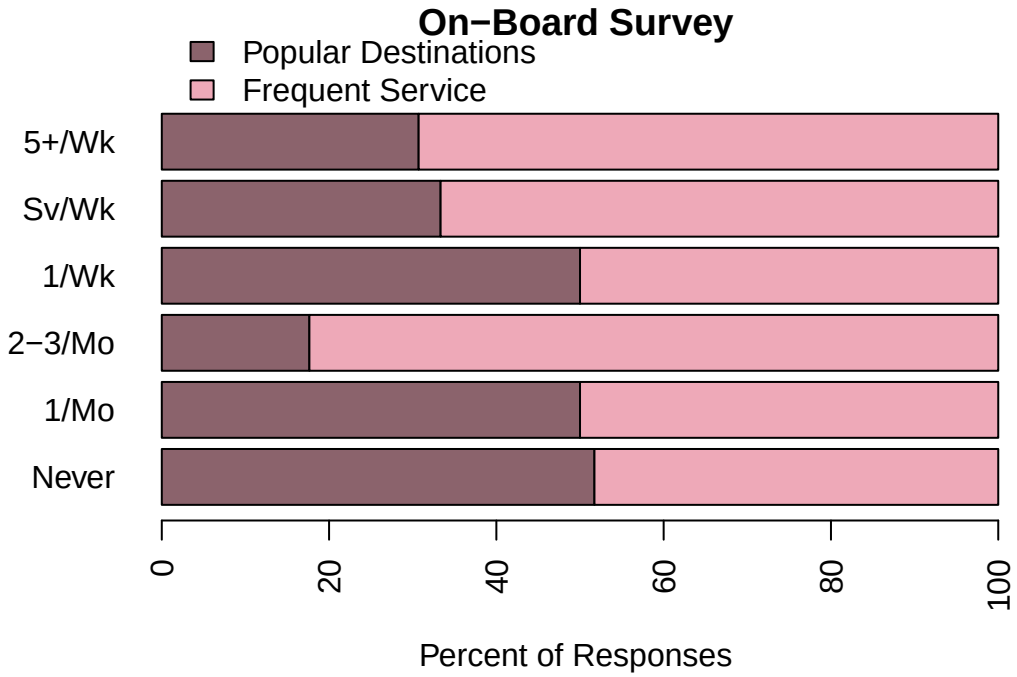


$$\textbf{p-value} = \mathbf{0.0020}$$

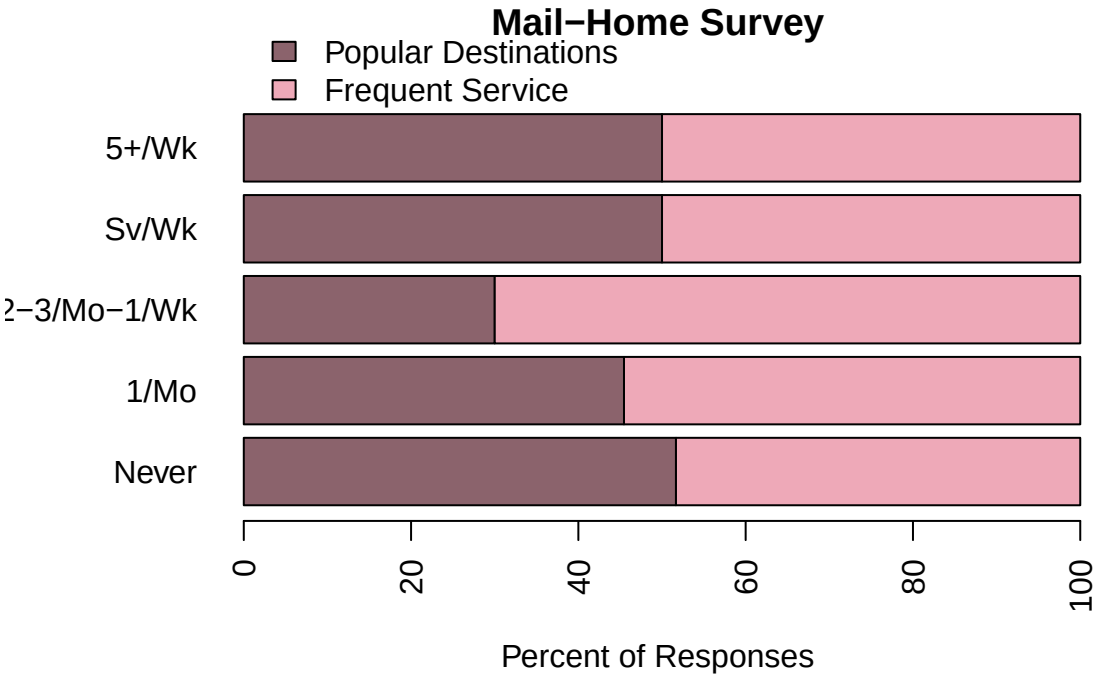


$$\textbf{p-value} = \mathbf{0.94}$$

Figure 50: Popular Destinations/Frequent Service vs. Typical Train Purpose



$\mathbf{p\text{-}value = 0.0086}$



$\mathbf{p\text{-}value = 0.49}$

Figure 51: Popular Destinations/Frequent Service vs. Bus Ridership

Table 16: On-Board Survey: Popular Destinations/Frequent Service vs. Bus Ridership

On-Board Survey
n = 329

	Never	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Popular Destinations	45	10	3	8	18	39
Frequent Service	42	10	14	8	36	88

Table 17: Mail-Home Survey: Popular Destinations/Frequent Service vs. Bus Ridership

Mail-Home Survey **n = 125**

	Never	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Popular Destinations	31	15	2	1	5	6
Frequent Service	29	18	5	2	5	6

corresponding participants selected popular destinations or frequent service. To calculate the p-value, bus trip purposes including the "airport" and "special events" out were included in the "Other" category because of low response numbers for both surveys. There were no responses for tourist attractions or dining out in either survey.

Table 18: On-Board Survey: Popular Destinations/Frequent Service vs. Bus Trip Purposes

n = 229
p-value = 0.066

	Work	Schl	Rec/Soc	Shop	Sp.Event	Air	Oth
Popular Destinations	30	14	10	15	4	0	3
Frequent Service	89	19	12	27	1	1	4

Table 19: Mail-Home Survey: Popular Destinations/Frequent Service vs. Bus Trip Purpose

n = 60
p-value = 0.84

	Work	Schl	Rec/Soc	Shop	Sp.Event	Airport	Oth
Popular Destinations	9	0	5	6	4	4	1
Frequent Service	8	0	5	5	7	3	3

The bus trip purpose of participants was not significant in either survey with

regards to whether they selected popular destinations or frequency as more important.

6.3 Current Transit Modes

Using the responses to the questions of train and bus ridership question, participants could be categorized as train-only, bus-only, train and bus or non-transit riders. In the on-board survey, there were only train-only as well as train and bus riders. In the mail-home survey, there were train-only, train and bus riders, as well as non-transit riders. There were no recorded bus-only riders. Having no bus-only riders was not expected, but is not surpriseing, as the MARTA bus system is largely a feeder system to the rail lines and it would be unusual, but not impossible, to find a bus-only rider.

Table 20: On-Board Survey: Popular Destinations/Frequent Service vs. Current Transit Modes

n = 291
p-value = 0.0039

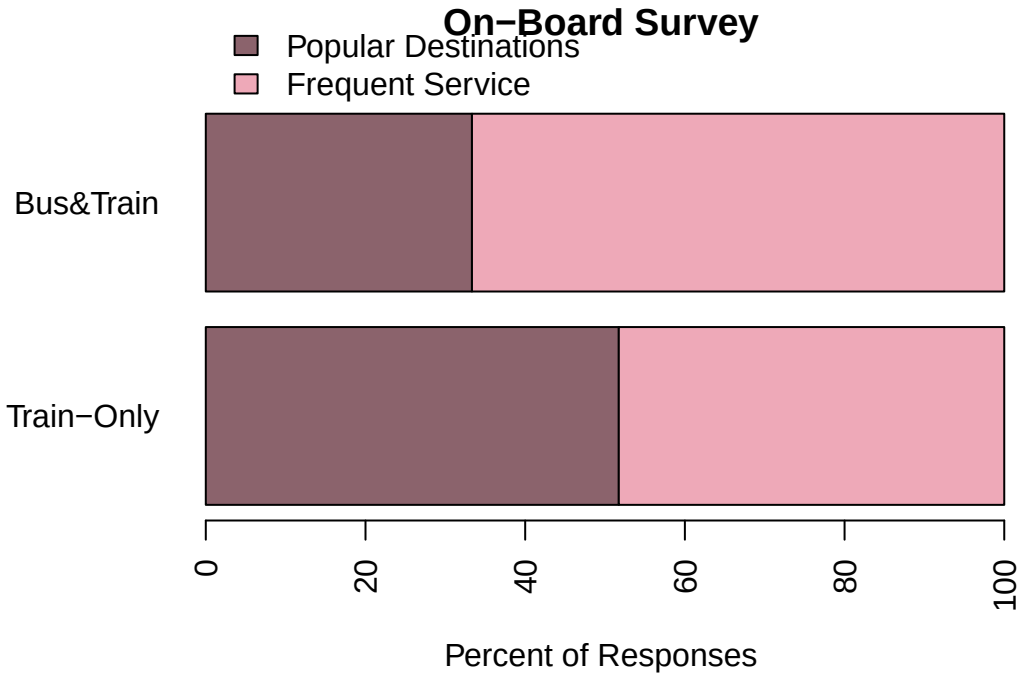
	Bus&Train	Train-Only
Popular Destinations	45	78
Frequent Service	42	156

Table 21: Mail-Home Survey: Popular Destinations/Frequent Service vs. Current Transit Modes

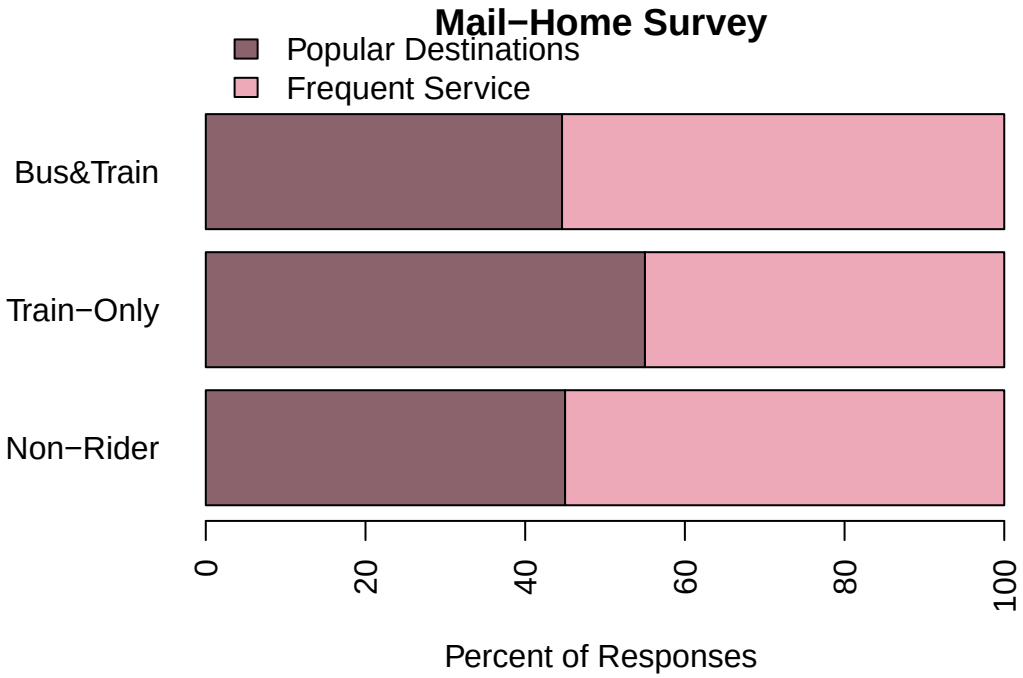
n = 125
p-value = 0.56

	Non-Rider	Train-Only	Bus&Train
Popular Destinations	9	22	29
Frequent Service	11	18	36

The current modes that participants take was significant in the on-board survey as illustrated by Figure 52. In the on-board survey, train-only riders were more likely to select popular destinations than were participants who currently ride the bus and the train. Current transit modes that participants take was not significant in the mail-home survey as expected because neither train or bus ridership were significant.



$$\textbf{p-value} = \mathbf{0.0039}$$



$$\textbf{p-value} = \mathbf{0.56}$$

Figure 52: Popular Destinations/Frequent Service vs. Current Transit Modes

6.4 Most Useful Map

The most useful map is also an important survey question. Participants were asked to rank the maps from one through four, with one being the most useful and four being the least useful. Understanding what was most useful to participants and whether they selected popular destinations or frequent service is important to check. Ideally, participants who selected popular destinations would have also ranked the popular destinations map as the most useful and those who selected frequent service would have ranked the frequency map as the most useful.

Table 22: On-Board Survey: Popular Destinations/Frequent Service vs. Most Useful map

n = 256
p-value = 0.0024

	ParknRide	Pop.Dest.	Frequency	Existing
Popular Destinations	14	62	14	19
Frequent Service	24	50	38	35

Table 23: Mail-Home Survey: Popular Destinations/Frequent Service vs. Most Useful map

n = 102
p-value = 0.047

	ParknRide	Pop.Dest.	Frequency	Existing
Popular Destinations	9	26	3	12
Frequent Service	10	16	12	14

Tables 22 and 23 show how participants responded to these questions and the p-value indicates whether or not the map ranking was significant. Figures 53 and 54 show how each group ranked the map they were expected to rank as the most useful. Figure 53 shows only how participants who chose popular destinations ranked the popular destinations map while Figure 54 shows only participants who selected frequent service and how they ranked the frequency map.

For those who selected popular destinations as more important 54% also selected the popular destination map as the most useful. However for those who chose

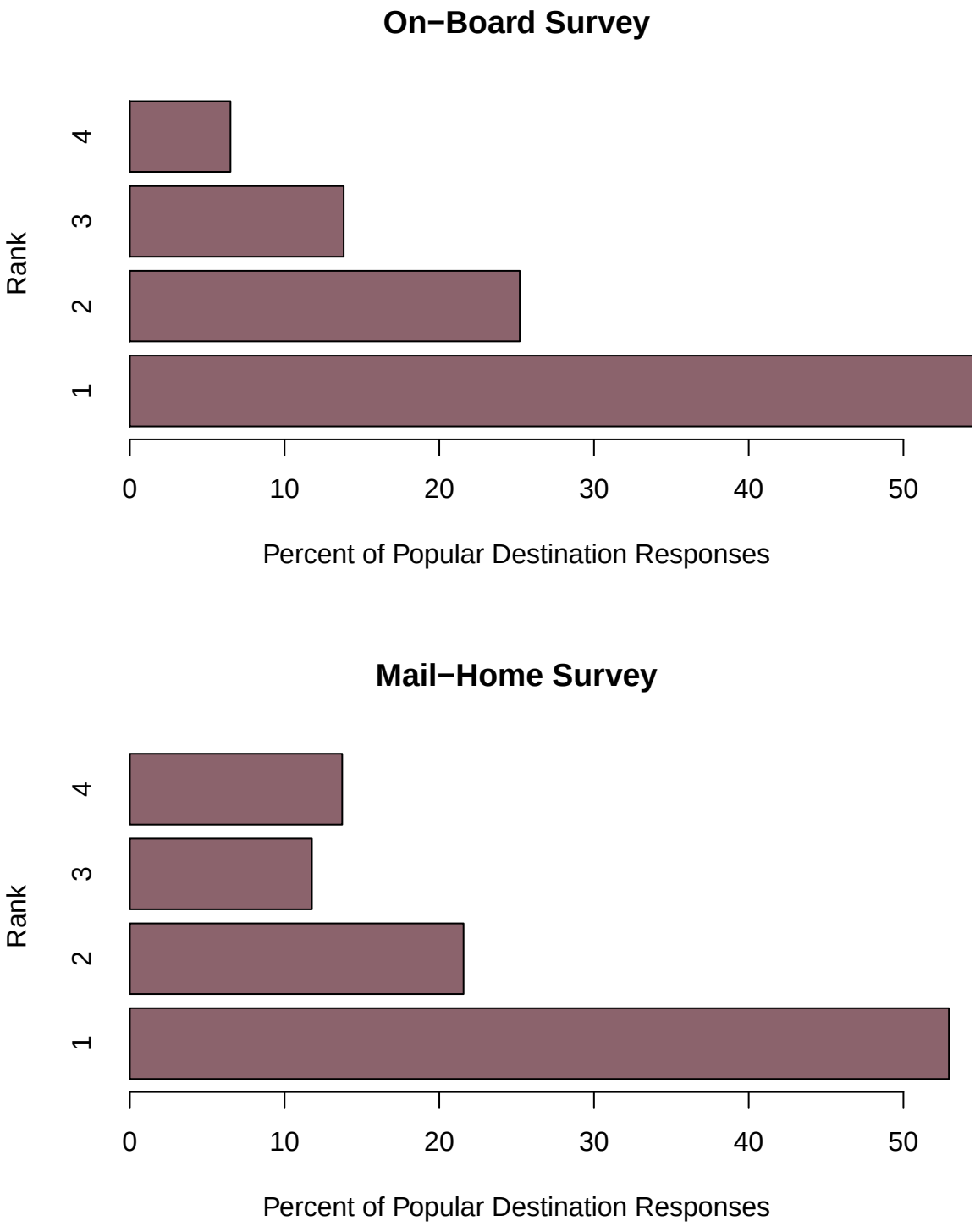


Figure 53: Participants Who Chose "Popular Destinations" Ranking of the Popular Destinations Map

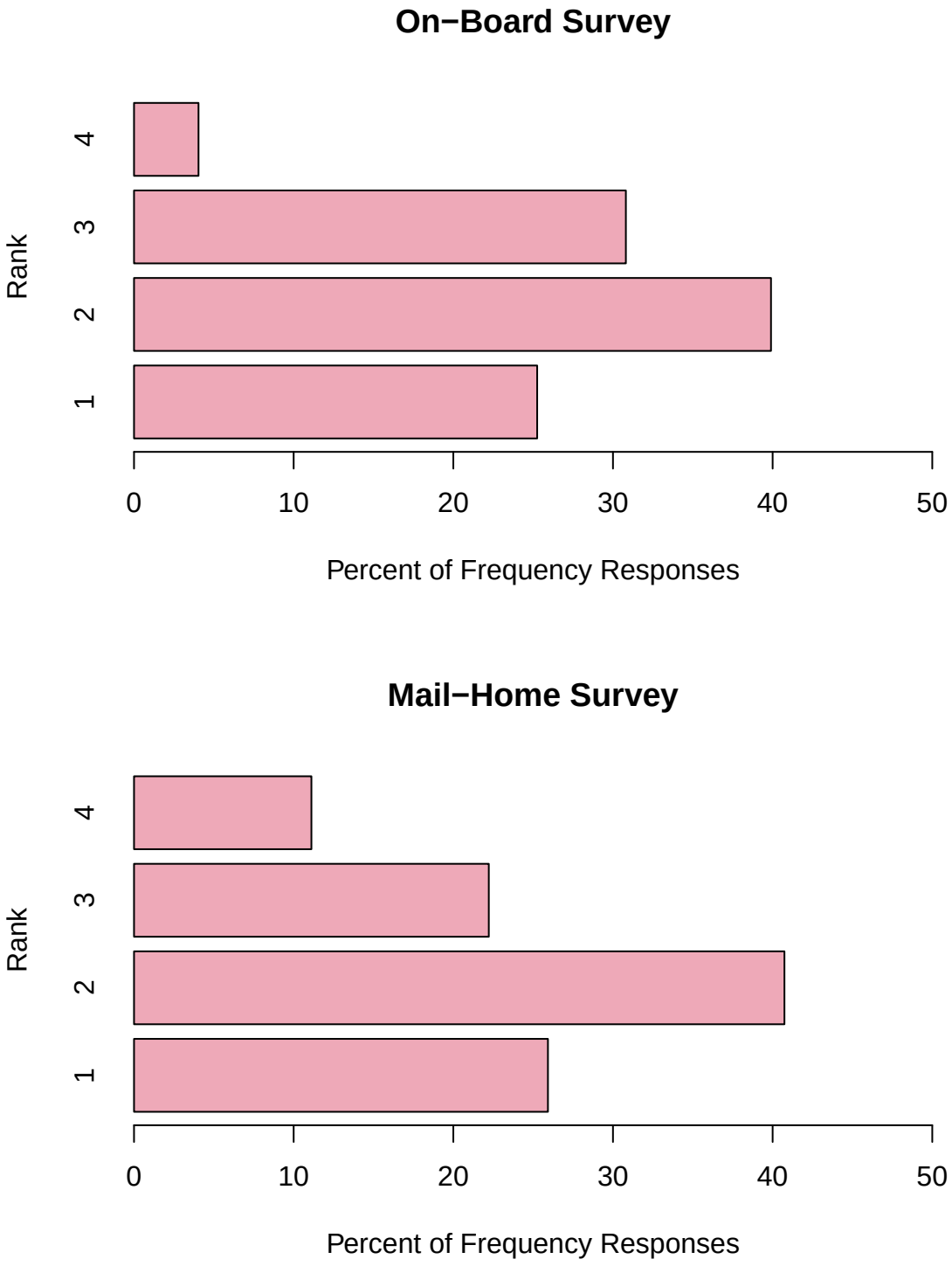


Figure 54: Participants Who Chose "Frequency" Ranking of the Frequency Map

frequency as the most important, only 25% responded that the frequency map was the most useful. Just over 70% of them ranked the frequency map as the second or third most useful, which happened in both surveys. This disconnect between which attribute is more important and which map was most useful indicates that for riders who want to see frequency, the frequency map presented in this survey was not as useful as the popular destinations map because the frequent service does not go where they want to go.

Looking at these figures and based on the statistical tests, it is clear that if someone answered "Popular Destinations" they were more inclined to answer that the Popular Destinations map was the most useful, however this was not the case for all participants. Selecting Popular Destinations as more important but not ranking the Popular Destinations Map as most useful could have been because of misunderstanding of the question, that the Popular Destinations Map does not include the popular destinations where the participants wished to go, or because of other reasons. The survey did not ask why participants ranked the surveys the way that they did.

In looking at how participants who chose frequent service as the most important, their responses to the most useful map do not match up. The majority ranked the Frequency Map as "2" or "3". One explanation for the disconnect between selecting frequency and how participants ranked the Frequency Map is that frequent service is important to them, but the map of frequent MARTA bus service is not useful to them and does not go where they need and want to go or that 20 minutes is not frequent enough to them. As mentioned earlier, there is a lack of frequent service throughout the MARTA system largely due to budget and service cuts within the last three years.

In Atlanta, the disconnect for frequency may be explained by large service cuts in MARTA over the last decade, which has reduced frequency and consolidated routes. However, usefulness ranking of the maps still illustrates the importance of

these maps as 78.4% of participants in the on-board survey and 73.6% of participants in the mail-home survey ranked one of the multi-modal maps as more useful than the existing MARTA rail map.

6.5 Licensure

Tables 24 and 25 summarize whether the ownership of a driver's license affected whether a participant preferred popular destinations or frequent service. Table 25 summarizes the Mail-Home Survey and does not include a chi-square p-value because the number of participants that do not have a driver's license was too small to perform the test.

Table 24: On-Board Survey: Popular Destinations/Frequent Service vs. Licensure
n= 262
p-value = 0.61

	No License	Licensed.
Popular Destinations	16	89
Frequent Service	29	128

Table 25: Mail-Home Survey: Popular Destinations/Frequent Service vs. Licensure
n= 116

	No License	Licensed
Popular Destinations	2	54
Frequent Service	3	57

According to the chi-square test, licensure does not significantly affect the stated preference of participants in the on-board survey. In the mail-home survey, the responses are evenly spread for all responses and does not seem to be significant despite the lack of the application of the chi-square test.

6.6 Household Vehicles

Understanding the effect that vehicles have is important to see how mobile a household is without transit. Tables 26 and 27 summarize the responses based on how many

vehicles are in the household. For the mail-home survey, there was only one household with four or more vehicles so it was included with the households with three vehicles as a category of three or more vehicles.

Table 26: On-Board Survey: Popular Destinations/Frequent Service vs. Household Vehicles

n = 263
p-value = 0.67

	0	1	2	3	4+
Popular Destinations	21	41	28	12	5
Frequent Service	43	51	39	17	6

Table 27: Mail-Home Survey: Popular Destinations/Frequent Service vs. Household Vehicles

n = 116
p-value = 0.51

	0	1	2	3+
Popular Destinations	6	19	25	6
Frequent Service	10	25	20	5

After examining the tables and p-values, there does not seem to be a strong inclination either way in both surveys. It seems that households with no cars were slightly more inclined to select frequent service, but there is no statistical difference.

6.7 Ethnicity

Ethnicity had fewer responses than other questions because Some participants had already left the survey or refused to answer. The responses "Middle Eastern", "Jewish", "Hispanic", "Native American", and "Other" were combined into one "Other" group because of a lack of responses in these categories. For the mail-home survey, "Asian" was also included in the "Other" category. Tables 28 and 29 list the responses for the on-board survey and the mail-home survey respectively.

While ethnicity was not found to be significant in either survey, it is interesting to note that the participants who ethnically identified themselves as "White" were

Table 28: On-Board Survey: Popular Destinations/Frequent Service vs. Ethnicity

n = 259

p-value = 0.092

	Black	Asian	White	Others
Popular Destinations	57	6	29	12
Frequent Service	103	7	24	21

Table 29: Mail-Home Survey: Popular Destinations/Frequent Service vs. Ethnicity

n = 112

p-value = 0.24

	Black	White	Others
Popular Destinations	27	22	6
Frequent Service	37	16	4

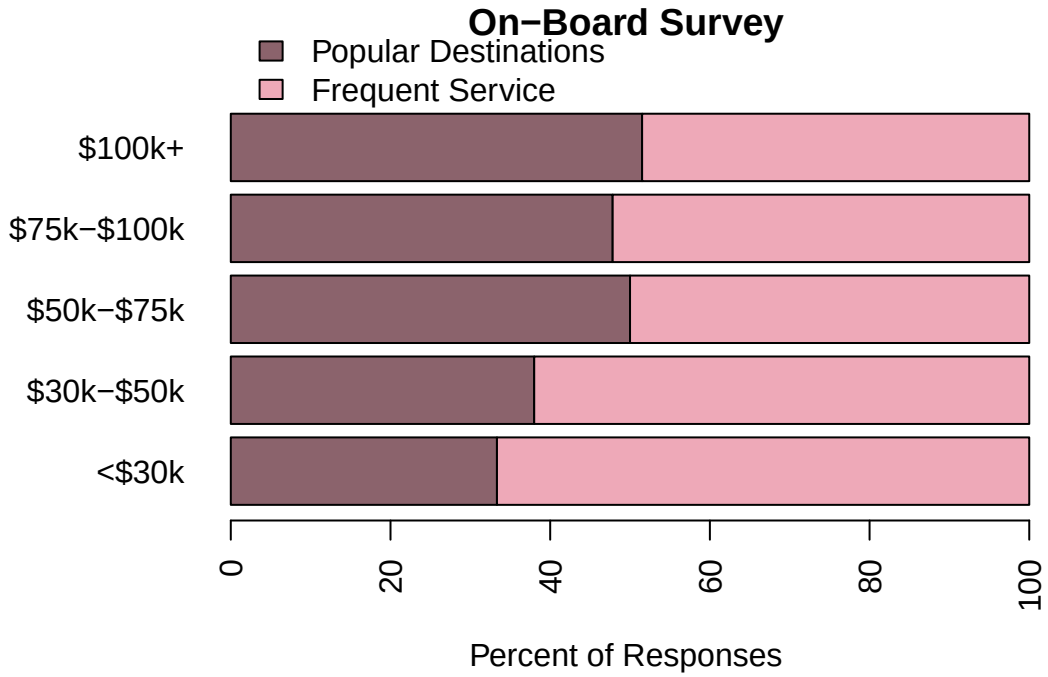
the only ethnic group that preferred popular destinations over frequent service in both surveys.

6.8 Income

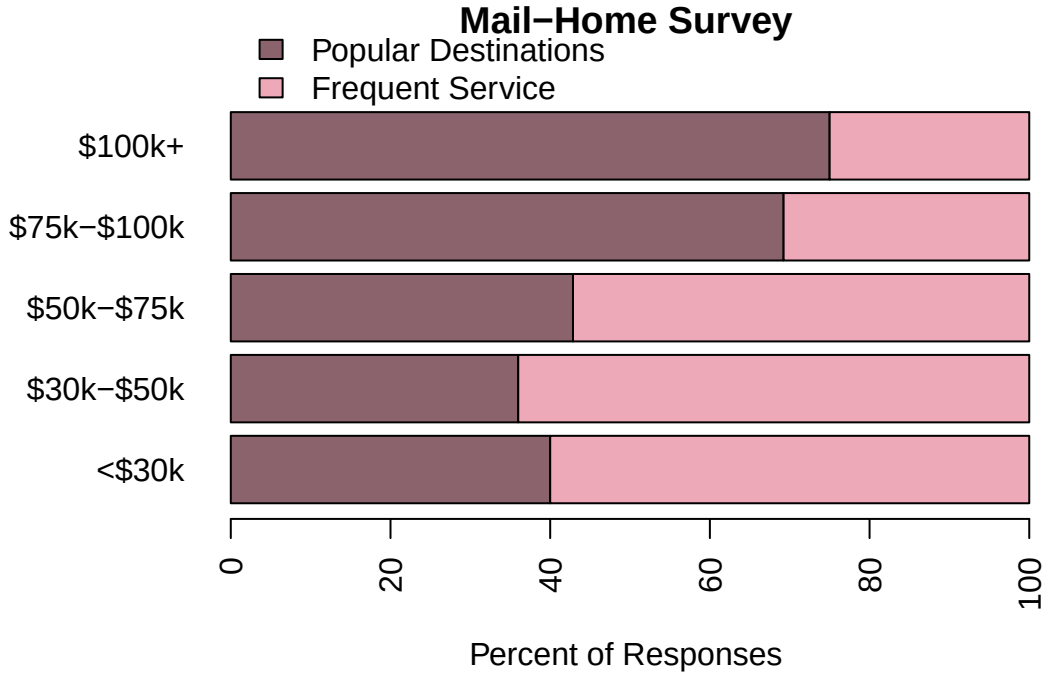
Income was another demographic category that was important to test because it may affect transportation choices, including how affordable vehicles and transit can be. It was also one of the questions that some participants chose not to answer. All of the answers that were blank, did not know, or did not answer were not included in the following table and chi-square calculations.

Tables 30 and 31 summarize income for those who responded in each survey. Examining these tables, there seems to be a general trend in the mail-home survey that higher incomes prefer popular destinations and that lower income households prefer frequency. In the on-board survey, the lower income households tended to prefer frequency as well, but there was no tendency for the higher income households and these were not statistically significant.

Based on the chi-square test, income was a significant factor in the mail-home



p-value = 0.35



p-value = 0.048

Figure 55: Popular Destinations/Frequent Service vs. Income

Table 30: On-Board Survey: Popular Destinations/Frequent Service vs. Income

n = 195

p-value = 0.35

	<$30k	$30k-$50k	$50k-$75k	$75k-$100k	$100k+
Popular Destinations	17	19	19	11	17
Frequent Service	34	31	19	12	16

Table 31: Mail-Home Survey: Popular Destinations/Frequent Service vs. Income

n = 110

p-value = 0.048

	<$30k	$30k-$50k	$50k-$75k	$75k-$100k	$100k+
Popular Destinations	14	9	9	9	12
Frequent Service	21	16	12	4	4

survey but not the on-board survey, as further illustrated in Figure 55. The households with higher incomes tended to select popular destinations rather than frequency.

6.9 Family Structure

Families with different structures may make different mode choices. For a single parent with multiple children, transit might not be an option regardless of how clear the maps are because it may be inconvenient. In the survey, the family structure was not a question. However, participants were asked how many adults (over eighteen) and children (under eighteen) there were in their household. Combining these answers, each participant was placed into a family structure category depending on the number of adults and children in the household. Tables 32 and 33 summarize how participants in different families responded.

The family structure was not statistically significant in either survey.

6.10 Summary of Results

For these statistical tests, an alpha value of 0.05 was used. Any test which yielded a p-values less than 0.05 was considered significant. Table 34 summarizes the chi-square p-values for all tested factors.

Table 32: On-Board Survey: Popular Destinations/Frequent Service vs. Family Structure

n = 259
p-value = 0.68

	Popular Destinations	Frequent Service
1 Adult, 0 Kids	22	34
1 Adult, Kid(s)	7	9
2 Adults, 0 Kids	28	37
2 Adults, Kid(s)	25	31
3 Adults, 0 Kids	10	26
3 Adults, Kid(s)	12	18

Table 33: Mail-Home Survey: Popular Destinations/Frequent Service vs. Family Structure

n = 114
p-value = 0.36

	Popular Destinations	Frequent Service
1 Adult, 0 Kids	13	19
1 Adult, Kid(s)	4	4
2 Adults, 0 Kids	17	23
2 Adults, Kid(s)	15	8
3 Adults	7	4

For the on-board survey, train ridership, train trip purpose, bus ridership, current transit modes, and what participants ranked as the most useful map were significant factors in whether participants selected popular destinations or frequent service as more important.

In the mail-home survey, current transit modes, the most useful map, and income were significant factors when examining how participants responded to the question of popular destinations or frequent service.

Income was the one factor that was significant in the mail-home survey that was not significant in the on-board survey. The higher income a household has, the more likely the participant was to select popular destinations as more important. While the general trend was the same with the on-board survey, the differences were not significant.

Table 34: Popular Destinations/Frequency Significant Factor Summary

Factor	On-Board Survey chi-square p-value	Mail-Home Survey chi-square p-value
Train Ridership	0.0038	0.53
Train Trip Purpose	0.0020	0.94
Bus Ridership	0.0086	0.49
Bus Trip Purpose	0.066	0.84
Current Transit Modes	0.0039	0.56
Most Useful Map	0.0024	0.047
Licensure	0.61	NA
Household Vehicles	0.67	0.51
Ethnicity	0.092	0.24
Income	0.35	0.048
Household Structure	0.68	0.31

In both surveys, there was a disconnect between whether participants said that frequency or popular destinations were important and which map they ranked as the most useful. The disconnect between which attribute is more important and which map is most useful is important because it addresses not only map design, but route and network design. As seen with the participants who thought frequency was the more important attribute but did not rank the frequency map as the most useful, there needs to be frequent service to places where riders and potential riders want to go. In this survey, it was clear that there was a disconnect between where the service was and where people wanted to be able to go. It is also a possibility that participants thought frequency was more important but that 20 minutes did not count as 'frequent' to them.

CHAPTER VII

ANALYSIS AND RESULTS: FUTURE BUS RIDERSHIP STATED PREFERENCE

This chapter presents the analysis and results for both the on-board and mail-home surveys for the question:

If one of these maps replaced the current MARTA overall map,
would you ride the bus more?

This question of future ridership is a stated preference question about whether participants think they would ride the bus more if these multi-modal maps were in place. While responses to stated preference questions are not binding or always entirely correct, they give a good idea of whether participants would consider something new.

In this chapter the responses and results of the two surveys will be statistically analyzed by calculating chi-square p-values between the responses to the question of future ridership and each of the following:

- Train Ridership and Trip Purpose
- Bus Ridership and Trip Purpose
- Current Transportation Mode Choices
- Most Useful Map
- Licensure
- Household Vehicles
- Ethnicity

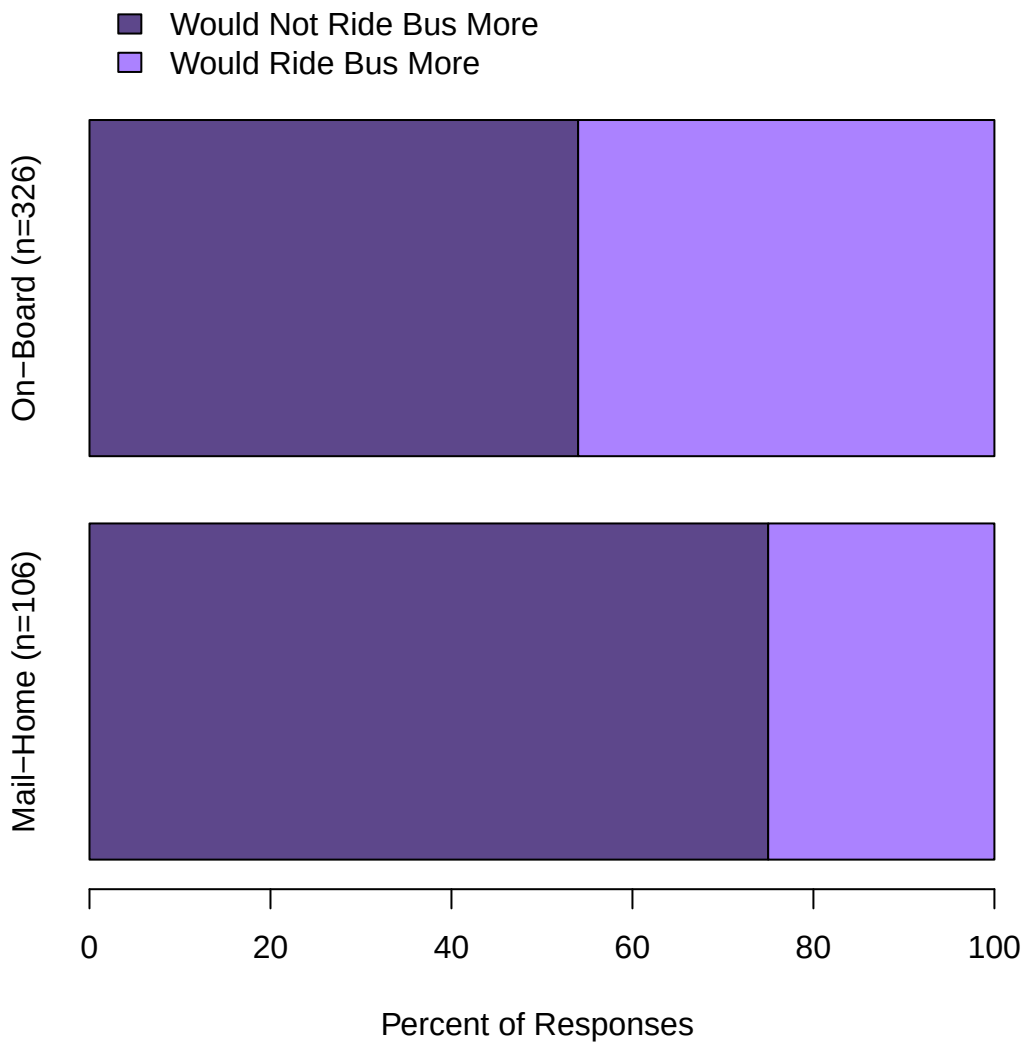


Figure 56: Summary: Stated Future Bus Ridership

- Income
- Household Structure

The total of 349 surveys were collected in the on-board survey. After excluding the responses from participants under eighteen and the participants that did not answer whether they would ride the bus more for various reasons, 326 responses were used in this analysis.

For the mail-home survey, 139 responses were recorded. Similarly, incomplete

responses for future bus ridership were excluded only for the analysis in this chapter. This total complete responses for the mail-home survey was 106 for this question.

Figure 56 summarizes how participants in each survey responded. Through comparative analysis, this chapter will go on to examine who would ride the bus more if these maps were in place.

7.1 Train Ridership and Trip Purpose

Train ridership is important to get an idea of how often participants use the train. The more often they use the train, the more often they see the schematic train maps and are familiar with the train system map. When participants were asked whether they would ride the bus more in the future if these maps were implemented, there were six possible responses; “”Never/First Time”, “One time or less per month”, “2-3 times per month”, “About once per week”, “Several times per week”, and “5+ times per week”. Summary Tables 35 and 36 show the train ridership of all participants and whether or not they responded that they would ride the bus more.

Table 35: On-Board Survey: Stated Future Bus Ridership vs. Train Ridership
n = 322

	Never	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Would Not Ride Bus More	10	17	9	7	30	102
Would Ride Bus More	5	6	15	2	36	83

Table 36: Mail-Home Survey: Stated Future Bus Ridership vs. Train Ridership
n = 106

	Never	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Would Not Ride Bus More	13	47	7	2	5	6
Would Ride Bus More	2	9	6	2	0	7

Due to some categories of low response, the six categories were reduced to three. The two lowest ridership answers, two middle answers, and two highest ridership answers were combined. Figure 57 shows these combined categories and resulting chi-square p-values for both the on-board and mail-home surveys.

Train ridership is significant in both surveys. Figure 57 indicates a general trend that the more a participant already rides the train, the more likely they were to respond that they would ride the bus more in the future.

In addition to how often participants ride the train, information was collected about the purpose of the majority of their train trips. Tables 37 and 38 summarize responses. Due to the lack of responses in some categories, the resulting p-value from the on-board survey was calculated by combining the responses to "Tourist Attractions", "Special Events", "Dining Out", and "Airport" were combined to make the chi-square value more accurate. For the mail-home survey, "Work/Commuting" was combined with "School" to make one category and "Tourist Attractions", "Dining Out", "Airport" were put into the "Other" category to calculate the p-value.

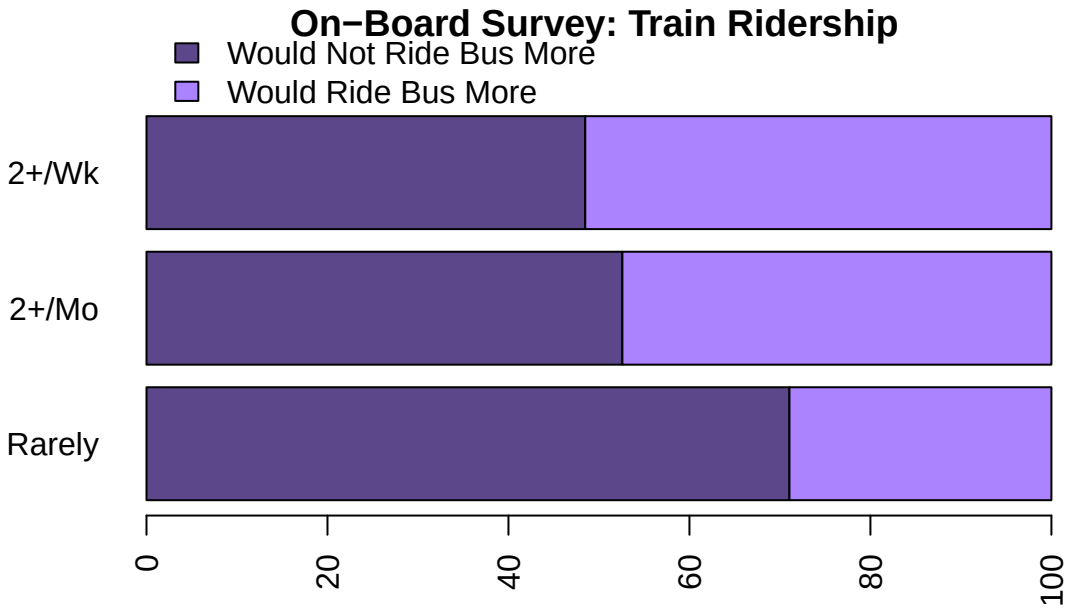
Table 37: On-Board Survey: Stated Future Bus Ridership vs. Train Trip Purpose
n = 308
p-value = 0.0075

	Work	Sch.	Rec/Soc	Shop	Attr.	Spec.	Dine	Air
Would Not Ride Bus More	111	19	8	16	2	1	2	10
Would Ride Bus More	77	26	12	21	0	2	0	1

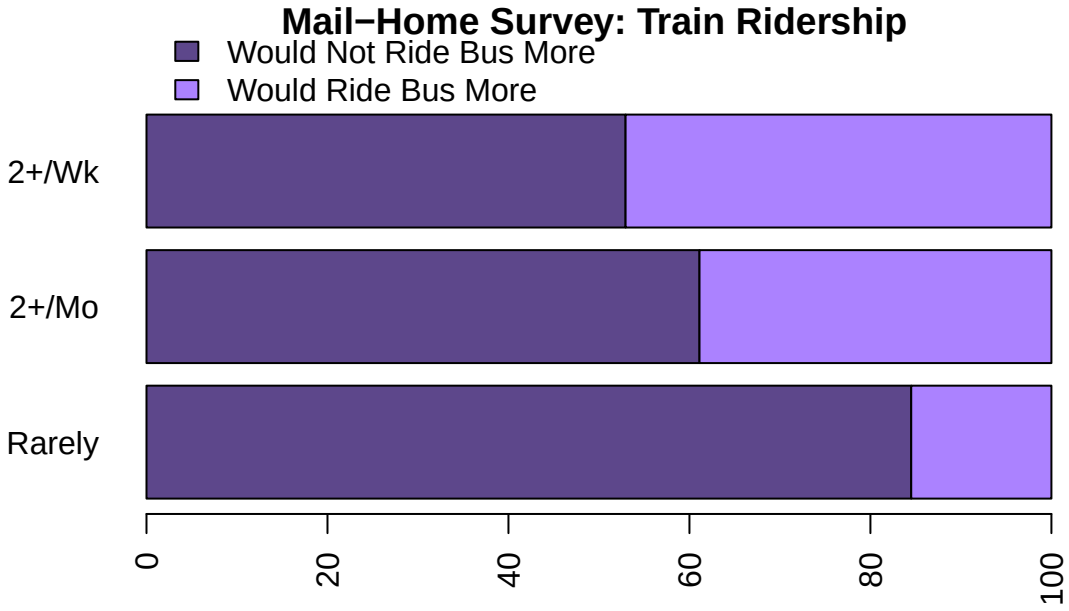
Table 38: Mail-Home Survey: Stated Future Bus Ridership vs. Train Trip Purpose
n = 90
p-value = 0.82

	Work	Sch.	Rec/Soc.	Shop	Attr.	Spec.	Dine	Air
Would Not Ride Bus More	14	1	15	6	1	19	1	10
Would Ride Bus More	6	1	6	2	0	5	0	3

The train trip purpose was not significant in the Mail-Home Survey, but it was significant in the on-board survey. In the on-board survey, participants whose purpose was "Work/Commuting" stated they would not ride the bus more, whereas almost all other categories tended to say that they would ride the bus more.



p-value = 0.080



p-value = 0.0075

Figure 57: Stated Future Bus Ridership vs. Train Ridership

p-value = 0.0075
p-value = 0.82

Figure 58: Train Trip Purpose

7.2 Bus Ridership and Trip Purpose

Tables 39 and 40 summarize the responses to bus ridership for the on-board and mail-home surveys respectively. Both tables indicate similar trends to those of train ridership, where the more often they ride the bus, the more likely they were to respond that they would ride the bus more in the future. These trends are illustrated in Figure 59. For the calculated p-values, two to three times per month and once per week were combined in the mail-home survey.

Table 39: On-Board Survey: Stated Future Bus Ridership vs. Current Bus Ridership

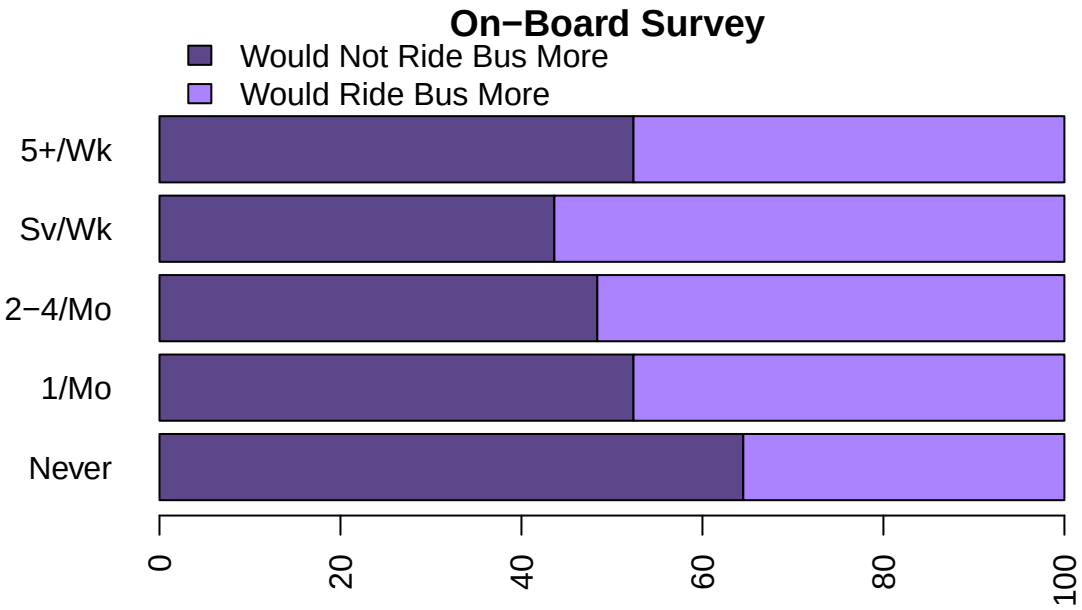
n = 326					
	Never	1/Mo	2-4/Mo	Sv/Wk	5+/Wk
Would Not Ride Bus More	60	11	15	24	66
Would Ride Bus More	33	10	16	31	60

Table 40: Mail-Home Survey: Stated Future Bus Ridership vs. Current Bus Ridership

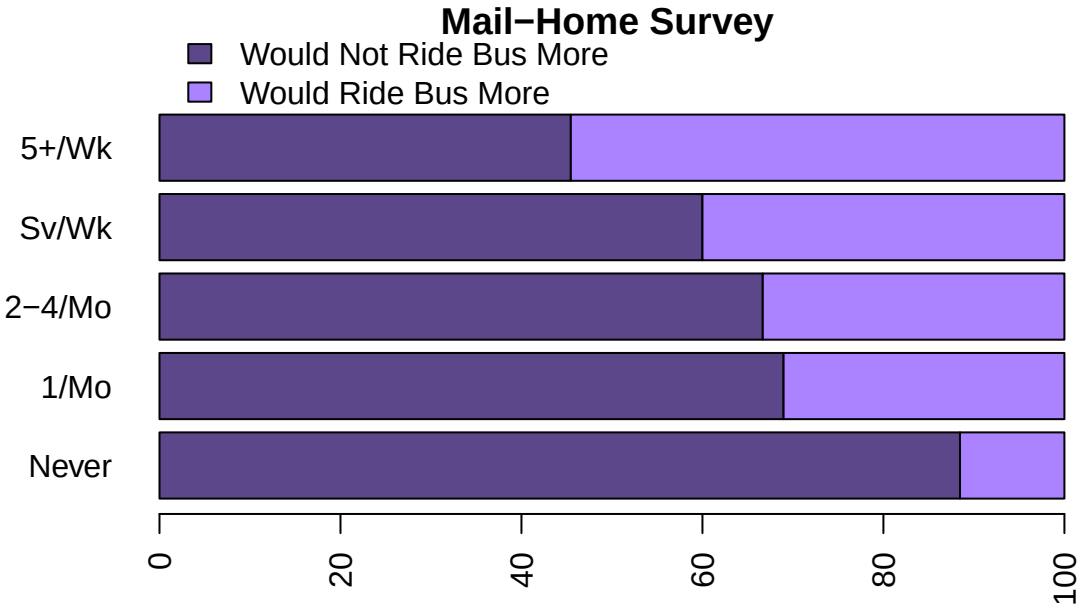
n = 106					
	Never	1/Mo	2-4/Mo	Sv/Wk	5+/Wk
Would Not Ride Bus More	46	20	6	3	5
Would Ride Bus More	6	9	3	2	6

While the general trend is that the more often a participant rides, the more likely they are to state that they would ride the train more, it is the categories including occasional riders (once per week) that do not adhere. In both surveys, these two categories were the ones with the fewest number of responses.

Bus trip purpose was also analyzed and is summarized in Tables 41 and 42. Any category that was omitted had no responses. For the on-board survey, "Special Events", "Dining Out", and "Airport" were combined with the "Other" category to perform the chi-square test.



p-value = 0.020



p-value = 0.013

Figure 59: Stated Future Bus Ridership vs. Current Bus Ridership

Table 41: On-Board Survey: Stated Future Bus Ridership vs. Bus Trip Purpose
n = 227
p-value = 0.25

	Work	Schl	Rec/Soc	Shop	Spec.	Dine	Air	Oth
Would Not Ride Bus More	71	12	9	17	3	1	0	1
Would Ride Bus More	54	20	11	23	2	0	1	2

Table 42: Mail-Home Survey: Stated Future Bus Ridership vs. Bus Trip Purpose
n = 49
p-value = 0.96

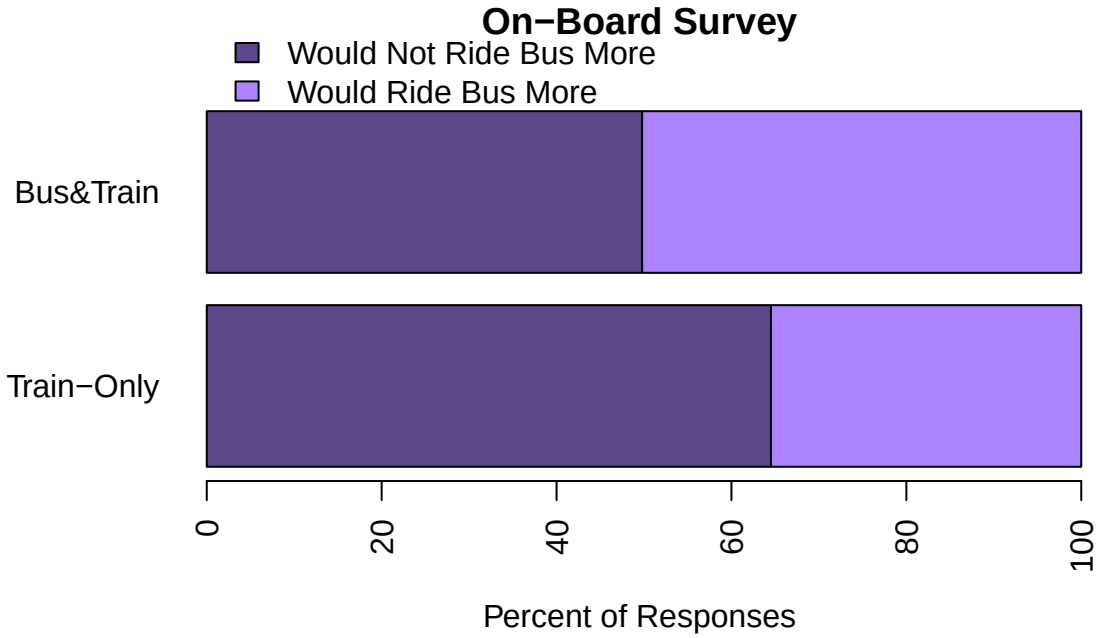
	Work/Schl	Rec/Soc	Shop	Spec	Air	Other
Would Not Ride Bus More	7	5	6	7	4	1
Would Ride Bus More	6	4	3	3	2	1

While the train trip purpose was significant for both surveys, the bus trip purpose was not significant in either survey.

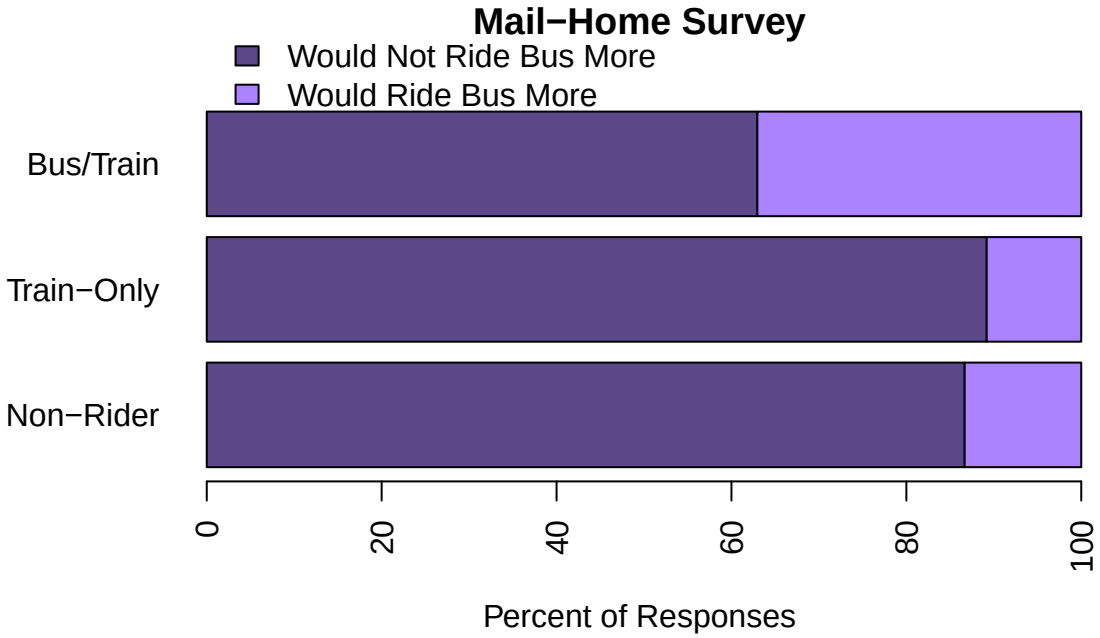
7.3 Current Transit Modes

Using the responses to the questions of train and bus ridership question, participants could be categorized as train-only, bus-only, train and bus or non-transit riders. In the on-board survey, there were only train-only as well as train and bus riders. In the mail-home survey, there were train-only, train and bus riders, as well as non-transit riders. There were no recorded bus-only riders, as discussed in chapter four. Obtaining no bus-only participants was not expected but is understandable because the MARTA bus system is largely a feeder system to the rail lines and it would be unusual, but not impossible, to find a bus-only rider.

The current transit modes that participants take was significant in both surveys, as shown in Figure 60. In both surveys, participants who already take both the bus and the train were the most likely to state that they would ride the bus more in the future.



$$\textbf{p-value} = \mathbf{0.022}$$



$$\textbf{p-value} = \mathbf{0.0094}$$

Figure 60: Stated Future Bus Ridership vs. Current Transit Modes

Table 43: On-Board Survey: Stated Future Bus Ridership vs. Current Transit Modes

n = 326

p-value = 0.022

	Train-Only	Bus&Train
Would Not Ride Bus More	60	116
Would Ride Bus More	33	117

Table 44: Mail-Home Survey: Stated Future Bus Ridership vs. Current Transit Modes

n = 106

p-value = 0.0094

	Non-Rider	Train-Only	Bus-Train
Would Not Ride Bus More	13	33	34
Would Ride Bus More	2	4	20

7.4 Most Useful Map

The most useful map is also an important survey question. Participants were asked to rank the maps from one through four, with one being the most useful and four being the least useful. Understanding what was most useful and whether participants stated they would ride the bus more in the future will reveal how participants who would ride the bus in the future depending on what they want to see.

Tables 45 and 46 summarize the map rankings and potential future ridership. Some participants incorrectly ranked the maps by either giving multiple maps the same rank or neglecting to rank them at all. These responses were not included.

The map that participants ranked as the most useful was not a significant factor in their stated preference for future bus ridership.

7.5 Licensure

Tables 47 and 48 summarize whether the ownership of a driver's license affected whether a participant stated that he/she would or would not ride the bus more in the future. Table 48 summarizes the mail-home survey and does not include a chi-square

Table 45: On-Board Survey: Stated Future Bus Ridership vs. Most Useful Map
n = 256
p-value = 0.12

	ParknRide	Pop.Dest.	Frequency	Existing
Would Not Ride Bus More	24	57	18	32
Would Ride Bus More	18	53	31	23

Table 46: Mail-Home Survey: Stated Future Bus Ridership vs. Most Useful Map
n = 92
p-value = 0.15

	ParknRide	Pop.Dest.	Frequency	Existing
Would Not Ride Bus More	16	25	10	19
Would Ride Bus More	2	13	4	3

p-value because the number of participants that do not have a driver's license was too small to perform the test.

Table 47: On-Board Survey: Stated Future Bus Ridership vs. Licensure
n= 268
p-value = 0.10

	No License	Licensed.
Would Not Ride Bus More	19	121
Would Ride Bus More	28	100

Table 48: Mail-Home Survey: Stated Future Bus Ridership vs. Licensure
n = 106

	No License	Licensed
Would Not Ride Bus More	1	79
Would Ride Bus More	3	23

According to the chi-square test, licensure does not significantly affect the stated preference of participants. However, there seems to be a general trend in both tables that unlicensed participants seemed more likely to state that they would ride the bus more. These insignificant p-values could be due to low response numbers.

7.6 Household Vehicles

The number of household vehicles is often associated with mobility and travel mode choice. These responses to future bus ridership and the number of household vehicles are summarized in Tables 49 and 50. In the mail-home survey, there was only one household with four or more vehicles. The category of four or more vehicles was included with three vehicles households to make one category of three or more vehicles.

Table 49: On-Board Survey: Stated Future Bus Ridership vs. Household Vehicles
n = 271
p-value = 0.55

	0	1	2	3	4+
Would Not Ride Bus More	32	55	37	19	4
Would Ride Bus More	32	40	33	12	7

Table 50: Mail-Home Survey: Stated Future Bus Ridership vs. Household Vehicles
n = 106
p-value = 0.21

	0	1	2	3	4+
Would Not Ride Bus More	7	31	33	9	
Would Ride Bus More	7	8	9	2	

In both surveys, the number of vehicles in the household does not seem to impact whether or not a participant stated they would ride the bus more in the future. It is interesting to note that in both surveys, the category of zero household vehicles was evenly split. Also, the only category that was more inclined to state that they would ride the bus more in the future was the households with four or more vehicles in the on-board survey, which was unexpected. While the chi-square tests indicate that the number of vehicles in the household is not significant in affecting the response to the stated preference question, it does seem that households with more vehicles were more inclined to say that they would not ride the bus more in the future.

7.7 Ethnicity

In the survey, the possible answers were "African American/Black", "Asian", "Middle Eastern", "Jewish", "Hispanic", "Caucasian/White", "Native American", as well as "Unknown", "Others, and "I don't know". These answers were selected so that in other examination of this survey data, the ethnicity could be compared to credit reporting data. For these surveys, the majority of the responses were "African American/Black", "Asian", and "Caucasian/White". For the on-board survey, all answers besides these three were combined into one "Others" category. In the mail-home survey, "Asian" was included in the "Other" category because of a low number of responses. Tables 51 and 52 summarize the recorded ethnicity data. Some participants did not care to share their ethnicity, or chose not to answer any demographic data. In this analysis as well as all demographic analyses, the total number of responses will change depending on the willingness of participants to answer personal questions.

Table 51: On-Board Survey: Stated Future Bus Ridership vs. Ethnicity
n = 266
p-value = 0.062

	Black	Asian	White	Others
Would Not Ride Bus More	81	7	36	16
Would Ride Bus More	85	9	16	16

Table 52: Mail-Home Survey: Stated Future Bus Ridership vs. Ethnicity
n = 104
p-value 0.19

	Black	White	Others
Would Not Ride Bus More	45	25	10
Would Ride Bus More	15	9	0

The ethnicity was not significant for either survey. In the on-board survey, the "White" category was the only category where the majority of the participants stated that they would not ride the bus more in the future. In the mail-home survey, the majority in all ethnicities stated they would not ride the bus more often and no

participants who identify with "Other" ethnicities stated that they would ride the bus more.

7.8 Income

Income was one of the questions that was answered the least in the survey. It was the last question and also very personal. Some participants did not get to the question, and some refused to answer. Tables 53 and 54 summarize the stated preference on future bus ridership as well as collected income data.

Table 53: On-Board Survey: Stated Future Bus Ridership vs. Income
n = 195
p-value = 0.37

	<$30k	$30k-$50k	$50k-$75k	$75k-$100k	$100k+
Would Not Ride Bus More	17	19	19	11	17
Would Ride Bus More	34	31	19	12	16

Table 54: Mail-Home Survey: Stated Future Bus Ridership vs. Income
n = 110
p-value = 0.45

	<$30k	$30k-$50k	$50k-$75k	$75k-$100k	$100k+
Would Not Ride Bus More	14	9	9	9	12
Would Ride Bus More	21	16	12	4	4

There was a general trend that households with lower incomes were more inclined to say that they would take the bus more in the future than households with higher incomes. However, income was not statistically significant in either survey.

7.9 Family Structure

Families with different structures may make different mode choices. For a single parent with multiple children, transit might not be an option regardless of how clear the maps are because it may be inconvenient. In the survey, the family structure was not a question. However, participants were asked how many adults (over eighteen) and children (under eighteen) there are in the household. Combining these answers,

each participant was placed into a family structure category depending on the number of adults and children in the household. Tables 55 and 56 summarize how participants in different families responded. For the p-value calculations, all households with three adults were combined in the mail-home survey.

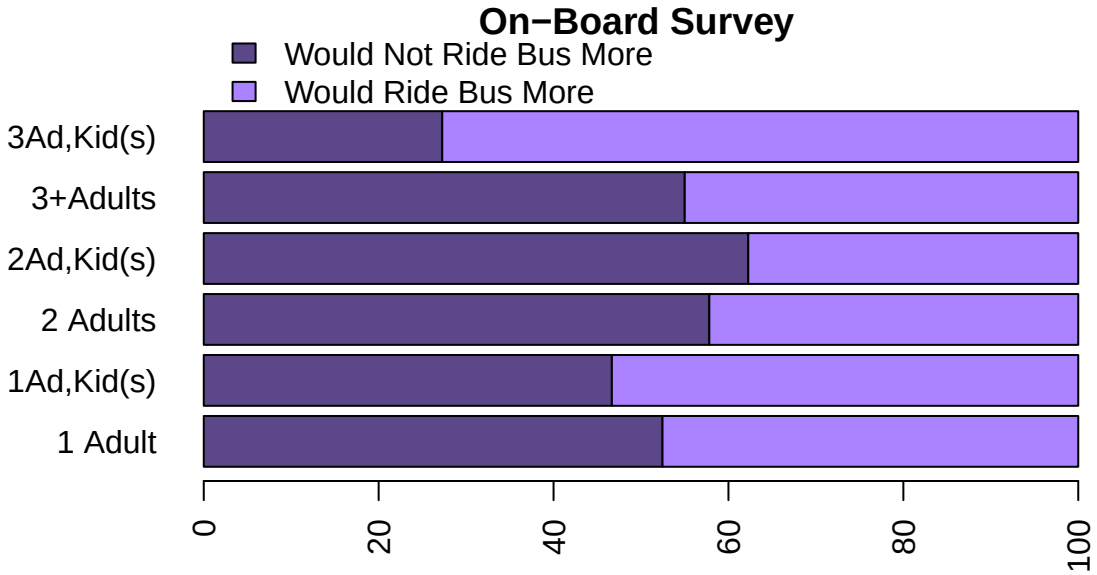
Table 55: On-Board Survey: Stated Future Bus Ridership vs. Family Structure
n = 266
p-value = 0.043

	Would Not Ride Bus More	Would Ride Bus More
1 Adult, 0 Kids	32	29
1 Adult, Kid(s)	7	8
2 Adults, 0 Kids	37	27
2 Adults, Kid(s)	33	20
3 Adults, 0 Kids	22	18
3 Adults, Kid(s)	9	24

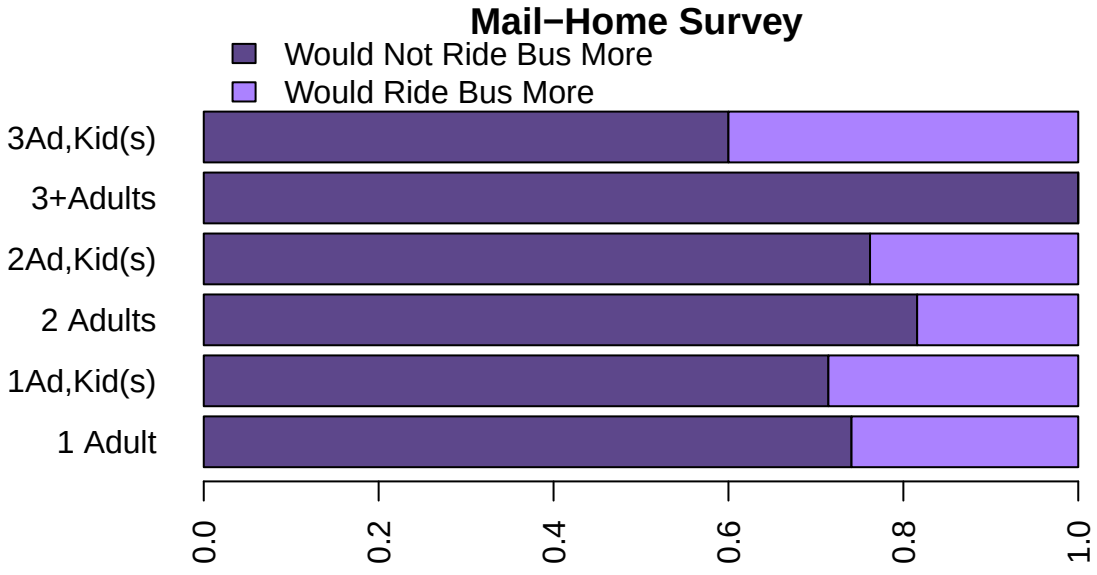
Table 56: Mail-Home Survey: Stated Future Bus Ridership vs. Family Structure
n = 104
p-value = 0.76

	Would Not Ride Bus More	Would Ride Bus More
1 Adult, 0 Kids	20	7
1 Adult, Kid(s)	5	2
2 Adults, 0 Kids	31	7
2 Adults, Kid(s)	16	5
3 Adults, 0 Kids	1	0
3 Adults, Kid(s)	6	4

The family structure was significant for the on-board survey, but not the mail-home survey. As displayed in Figure 61, in the on-board survey, it was the households with three adults and children and one adults and children that were more likely to state that they would ride the bus more in the future. The family structures that were most likely to state that they would not ride the bus in the future were the households with two adults and children as well as the households with two or three adults and no children.



p-value = 0.043



p-value = 0.76

Figure 61: Stated Future Bus Ridership vs. Family Structure

Table 57: Future Bus Ridership Significant Factor Summary

Factor	On-Board Survey chi-square p-value	Mail-Home Survey chi-square p-value
Train Ridership	0.080	0.0075
Train Trip Purpose	0.0075	0.82
Bus Ridership	0.020	0.013
Bus Trip Purpose	0.25	0.96
Current Transit Modes	0.022	0.0094
Most Useful Map	0.12	0.15
Licensure	0.10	NA
Household Vehicles	0.55	0.21
Ethnicity	0.062	0.19
Income	0.37	0.45
Household Structure	0.043	0.76

7.10 Summary of Results

Table 57 shows the chi-square p-values for each factor. All of the p-values that are less than 0.05 are significant.

In both surveys, the current train ridership, bus ridership, and current transit mode choices were significant. Participants tended to say they would ride the bus more if they already did. The non-bus riders need more than the better maps to change their transit ridership habits.

It is interesting to note that in both surveys, it is the riders who reported that they ride about once per week that were the group that was the most likely to state that they would ride the bus more. However, it is important to note that participants who ride once per week was the ridership category with the smallest amount of responses.

In both surveys, participants who already ride both the bus and the train were more likely to state that they would ride the bus more in the future, while train-only and non-riders stated that they would not.

Additionally, in the on-board survey, the train trip purpose and the household

structure were significant factors. Participants whose train trip purpose was "airport", "dining out", or "tourist attractions" almost always stated that they would not ride the bus more. However participants with more regular train trip purposes were more likely to state that they would ride the bus more in the future. With regards to family structure, families with two adults with or without children and households with three adults and no children were the least likely to ride the bus more. It is interesting that households with three adults and at least one child were the most likely household structure to ride the bus more.

CHAPTER VIII

ANALYSIS AND RESULTS: STATED PREFERENCE FUTURE OVERALL UNDERSTANDING

This chapter presents the analysis and results for both the on-board and mail-home surveys for the question:

If one of these maps replaced the current MARTA overall map,
would it help your understanding of the overall MARTA system?

This question of whether participants would better understand the system if these maps were implemented is a stated preference question about whether participants think they would understand the overall MARTA system better if these multi-modal maps were in place. While responses to stated preference questions are not binding or always entirely correct, they give a good idea of whether participants would consider something new.

In this chapter the responses and results of the two surveys will be statistically analyzed through chi-square tests with responses to the following characteristics:

- Train Ridership and Trip Purpose
- Bus Ridership and Trip Purpose
- Current Transportation Mode Choices
- Most Useful Map
- Licensure
- Household Vehicles
- Ethnicity

- Income
- Household Structure

The total of 349 surveys were collected in the on-board survey. In the on-board survey the question of future understanding was formatted as open-ended in the tablet. Even though the question was asked as a "yes" or "no" question to participants, some did not answer and some responded with an irrelevant answer. Because some did not provide a relevant answer, there is a higher number of participants that did not answer this question. After excluding the responses from participants under eighteen and those that did not answer this question for various reasons, 242 responses were used in this analysis. For the mail-home survey, 138 responses were recorded in total. Similarly, incomplete responses for this question were excluded only for the analysis in this chapter, which brought the total to 105. Some people chose not to answer this question or were too unsure to provide a response. Figure 62 shows how the two surveys responded.

8.1 Train Ridership and Trip Purpose

Tables 58 and 59 summarize whether participants thought their understanding would change along with their reported current train ridership.

Table 58: On-Board Survey: Stated Future Understanding vs. Train Ridership

n = 238

	Rarely	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Would Not Understand	4	5	5	3	12	64
Would Understand	5	11	10	3	33	83

Table 59: Mail-Home Survey: Stated Future Understanding vs. Train Ridership

n = 105

	Never	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Would Not Understand More	6	21	2	1	3	6
Would Understand More	10	36	10	3	2	5

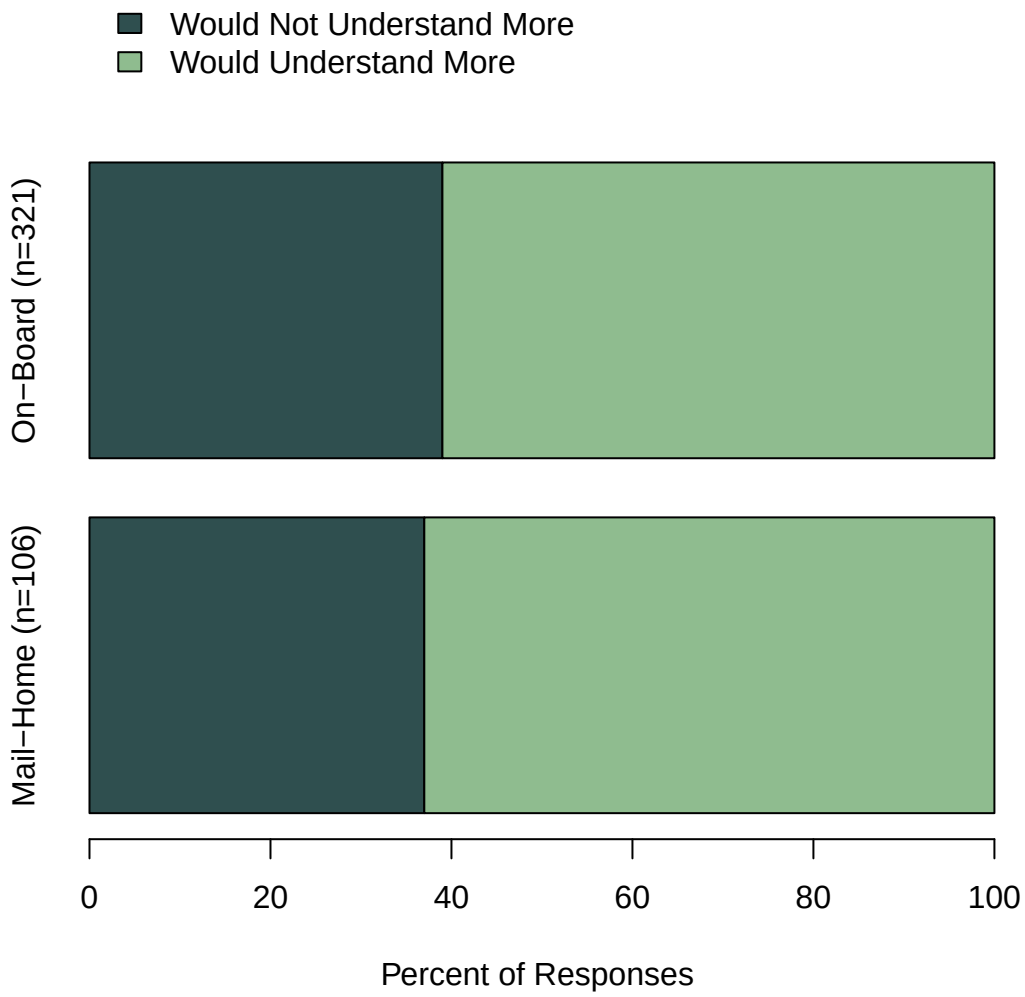
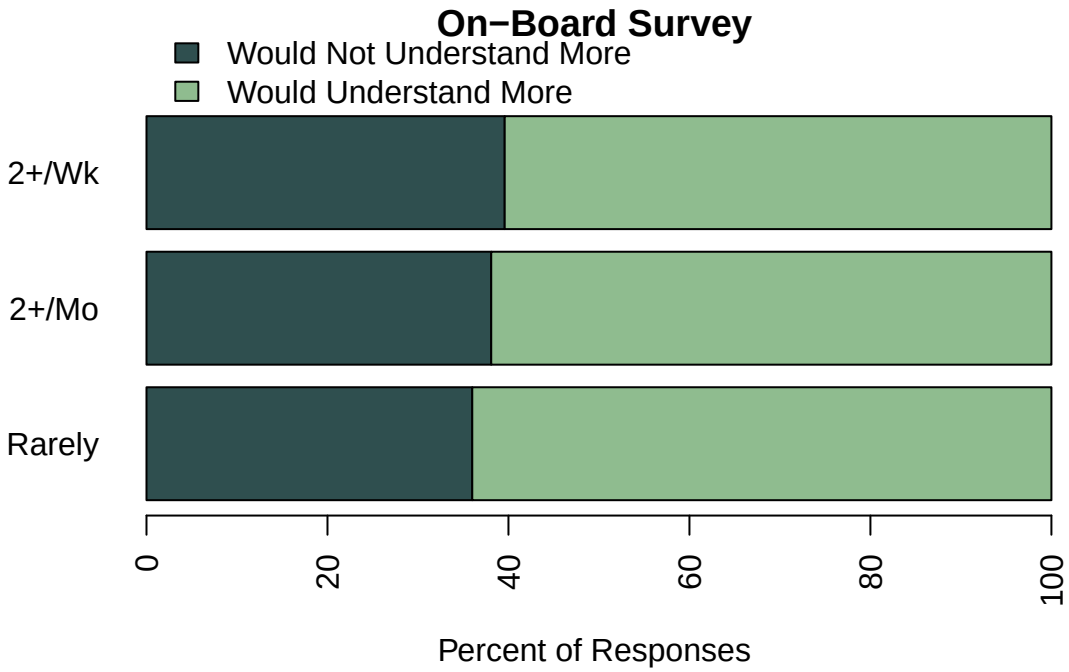


Figure 62: Stated Future Understanding Summary

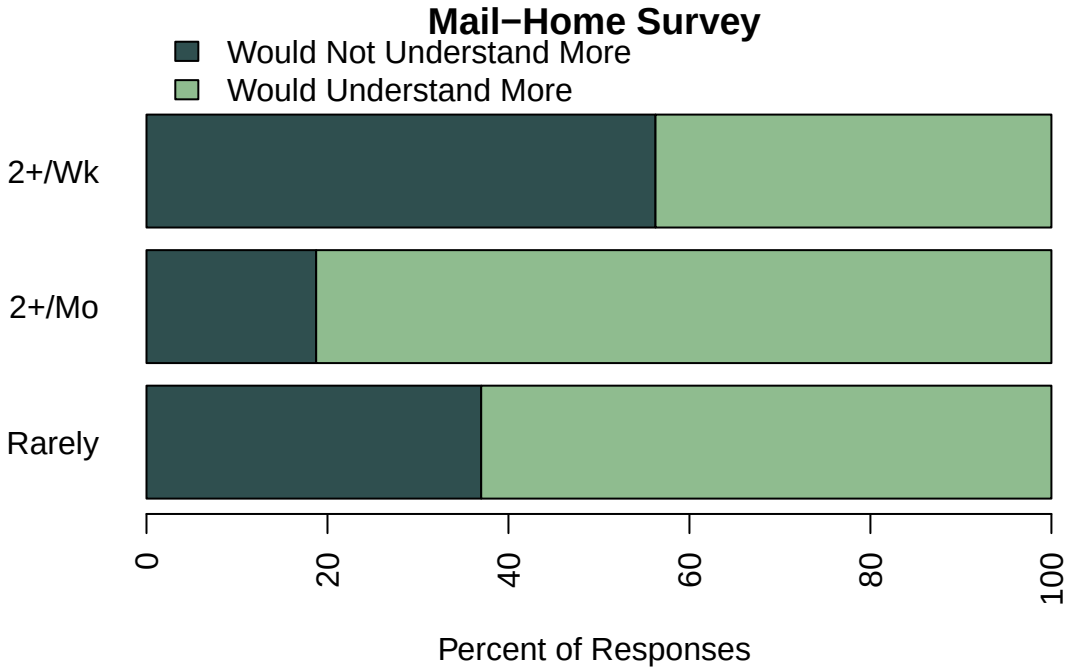
Due to some categories of low response, the six categories were reduced to three. The two lowest ridership answers, two middle answers, and two highest ridership answers were combined. Figure 63 shows these combined categories and resulting chi-square p-values for both the on-board and mail-home surveys.

While neither is significant, there seems to be a general trend in the mail-home survey that those who are the most and least frequent train riders think that their system understanding would increase. The on-board survey is much different, showing almost no difference between the categories.

Tables 60 and 61 summarize the bus trip purposes and how participants thought



$$\textbf{p-value} = \mathbf{0.94}$$



$$\textbf{p-value} = \mathbf{0.090}$$

Figure 63: Stated Future Understanding vs. Train Ridership

their understanding might change. Due to low response numbers in some categories, to calculate the chi-square p-value, the "Tourist Attractions", "Special Events", "Dining Out", and "Airport" were combined into one "Other" category for the on-board survey. In the mail-home survey, for the calculations, "Work/Commuting" and "School/College" were combined into one category and 'Tourist Attractions", "Special Events", and "Airport" were combined into one category.

Table 60: On-Board Survey: Stated Future Understanding vs. Train Trip Purpose
n = 228
p-value = 0.022

	Work	Sch.	Rec/Soc	Shop	Attr.	Spec.	Dine	Air
Would Not Understand More	66	6	4	8	2	1	0	1
Would Understand More	76	28	9	17	0	2	1	7

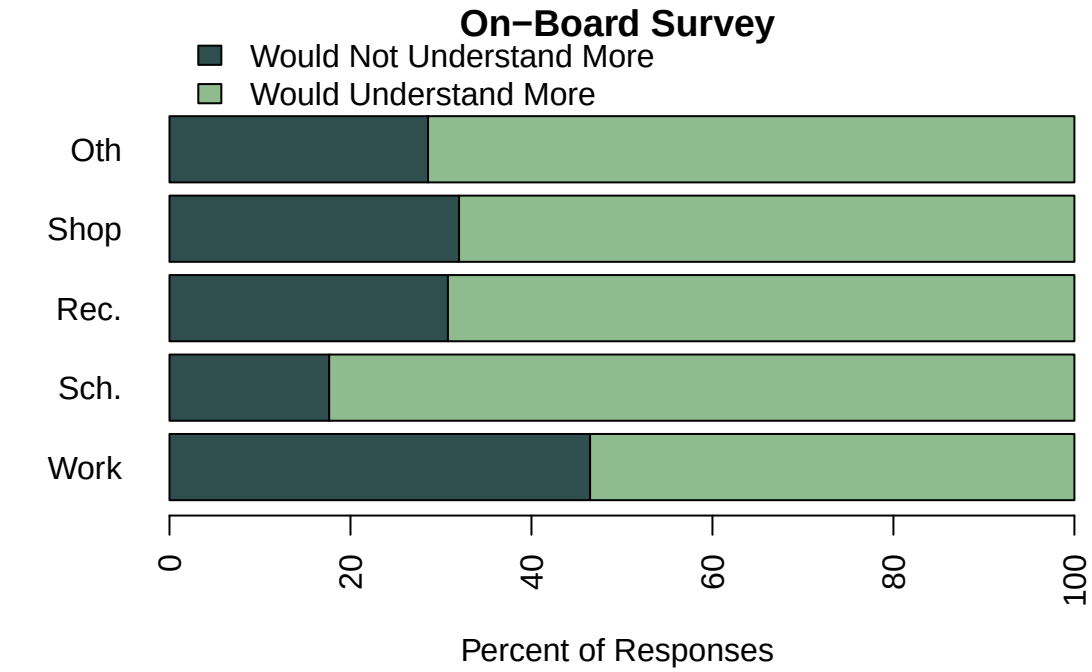
Table 61: Mail-Home Survey: Stated Future Understanding vs. Train Trip Purpose
n = 88
p-value = 0.84

	Work	Sch.	Rec/Soc	Shop	Attr.	Spec.	Air
Would Not Understand More	9	0	7	3	0	9	5
Would Understand More	10	1	14	4	1	16	9

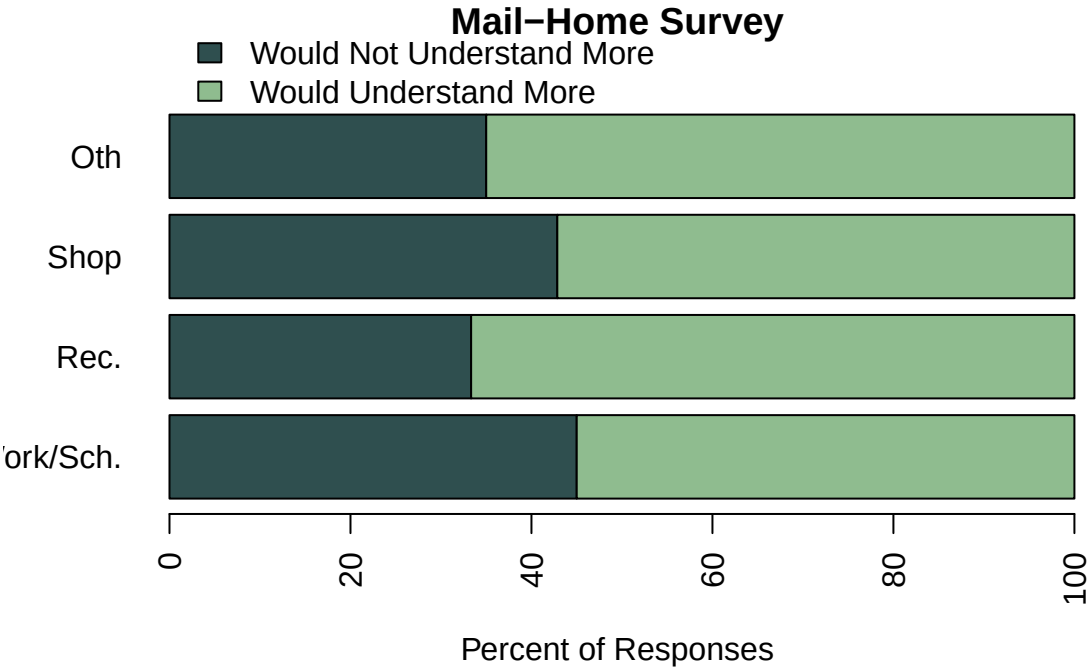
The train trip purpose is significant for the on-board survey, but not the mail-home survey, as illustrated in Figure 64, where the participants who ride the train to work/school who are significantly more likely to state that they would understand the overall system more in the future.

8.2 Bus Ridership and Trip Purpose

Tables 62 and 63 summarize bus ridership responses for both surveys. For the mail-home survey p-value calculations, the ridership categories were condensed into three categories due to low numbers of occasional and frequent riders. Bus ridership was not significant in either survey.



$\mathbf{p\text{-}value = 0.022}$



$\mathbf{p\text{-}value = 0.84}$

Figure 64: Stated Future Understanding vs. Train Trip Purpose

Table 62: On-Board Survey: Stated Future Understanding vs. Bus Ridership
n = 242
p-value = 0.34

	Never	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Would Not Understand More	29	5	7	5	9	39
Would Understand More	41	11	4	7	25	60

Table 63: Mail-Home Survey: Stated Future Understanding vs. Bus Ridership
n = 105
p-value = 0.37

	Never	1/Mo	2-3/Mo	1/Wk	Sv/Wk	5+/Wk
Would Not Understand More	14	14	3	0	2	6
Would Understand More	38	16	2	3	3	4

Table 64: On-Board Survey: Stated Future Understanding vs. Bus Trip Purpose
n = 167
p-value = 0.18

	Work	Sch.	Rec/Soc	Shop	Spec.	Air	Oth
Would Not Understand More	40	4	5	9	2	0	3
Would Understand More	53	19	12	15	3	1	1

Table 65: Mail-Home Survey: Stated Future Understanding vs. Bus Trip Purpose
n = 48
p-value = 0.51

	Work/Schl	Rec/Soc	Shop	Spec	Air	Other
Would Not Understand More	8	3	2	5	2	1
Would Understand More	6	5	6	4	5	1

Tables 64 and 65 summarize the responses to the bus trip purpose. It is important to note that the total responses to bus ridership are low because not all participants stated that they ride the bus. For the p-value calculations, "Special Events", "Airport", and "Other" were all combined into one category to account for the small number of responses in each of these categories. Based on the p-values, the bus trip purpose was not significant in either survey.

8.3 Current Transit Modes

Using the responses to train and bus ridership, transit modes that participants take could be determined. Tables 66 and 67 summarize which modes participants currently use and whether or not they responded that their bus ridership would increase. It is important to note there are no non-train riders in the on-board survey because it was performed on board MARTA trains and inside the fare gates at MARTA transit stations. It is also interesting to note that there are no bus-only riders in the mail-home survey, which is not surprising as the MARTA bus system is mostly a feeder system to the rail lines.

Table 66: On-Board Survey: Stated Future Understanding vs. Current Transit Modes

n = 242
p-value = 0.70

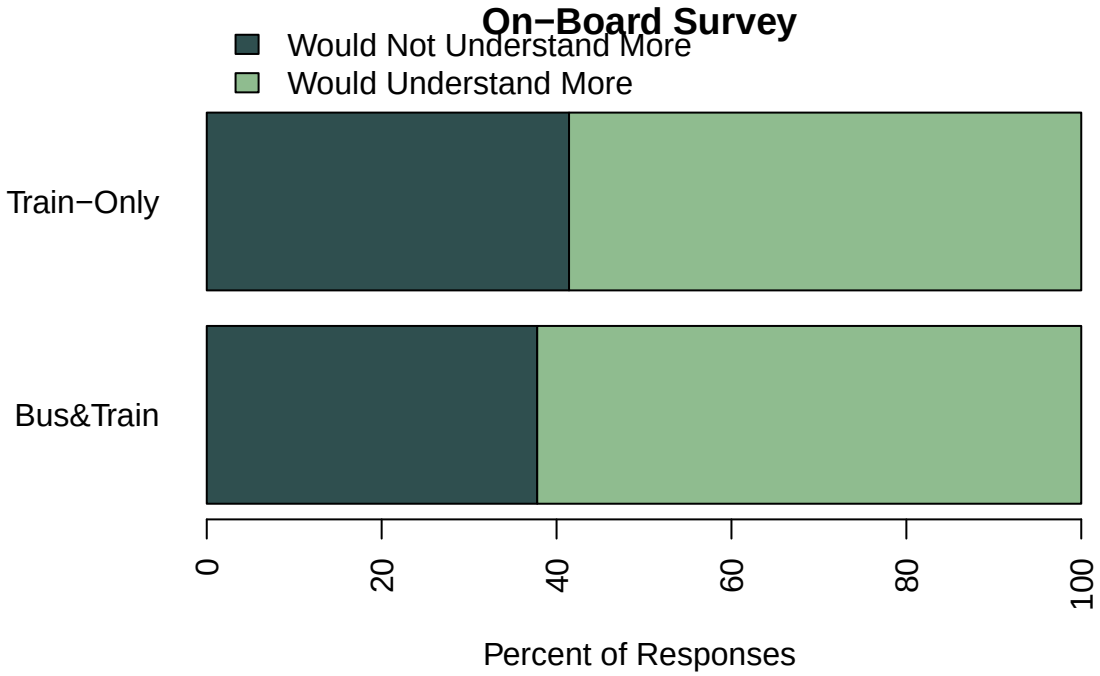
	Bus&Train	Train-Only
Would Not Understand More	65	29
Would Understand More	107	41

Table 67: Mail-Home Survey: Stated Future Understanding vs. Current Transit Modes

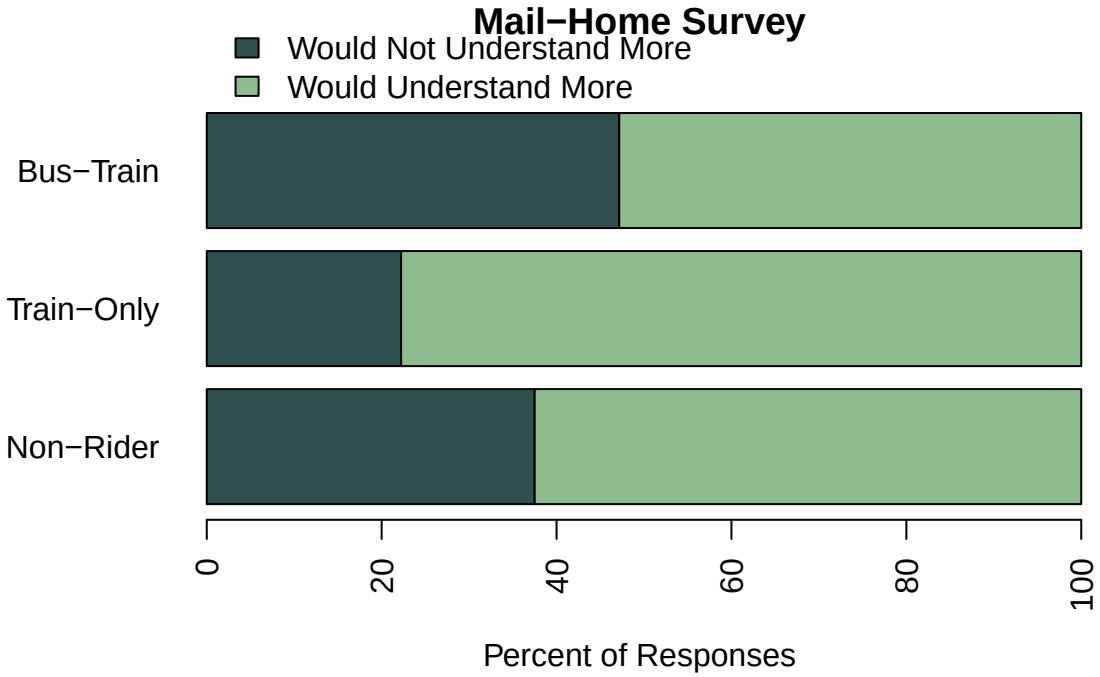
n = 105
p-value = 0.057

	Non-Rider	Train-Only	Bus-Train
Would Not Understand More	6	8	25
Would Understand More	10	28	28

While the current modes are not significant in either survey, there is a large difference between the two surveys, 0.057 for the on-board and 0.70 for the mail-home survey. When examining Figure 65, it is interesting to note that in the mail-home survey, it is the train-only riders that most often state that their understanding would not improve. It could be that these participants see the maps everyday and are used to it or it could be that these participants are train-only by choice and do not even care to understand maps that include bus routes.



p-value = 0.70



p-value = 0.057

Figure 65: Stated Future Understanding vs. Current Transit Modes

8.4 Most Useful Map

Understanding whether the participants stated they would understand the system more and the map that they found the most useful is important. Their ranking of the usefulness of the maps serves as a link between the map that increases their understanding. Tables 68 and 69 summarize how participants responded to their future understanding and the map that they thought was the most useful.

Table 68: On-Board Survey: Stated Future Understanding vs. Most Useful map
n = 199
p-value = 0.014

	ParknRide	Pop.Dest.	Frequency	Existing
Would Not Understand More	10	20	15	22
Would Understand More	17	67	27	21

Table 69: Mail-Home Survey: Stated Future Understanding vs. Most Useful map
n = 91
p-value = 0.55

	ParknRide	Pop.Dest.	Frequency	Existing
Would Not Understand More	9	13	3	9
Would Understand More	9	24	9	15

Which map participants ranked as the most useful was significant for the on-board survey, but not the mail-home survey. In the on-board survey, participants who ranked the popular destinations map as the most useful were the group most likely to state that they would understand the overall system the most in the future. The mail-home survey provided the same results, however they were not statistically significant.

8.5 Licensure

Tables 70 and 71 summarize how participants answered according to whether they are licensed to drive or not. There were not enough responses from participants in the mail-home survey who were not licensed to perform a chi-square calculation, so

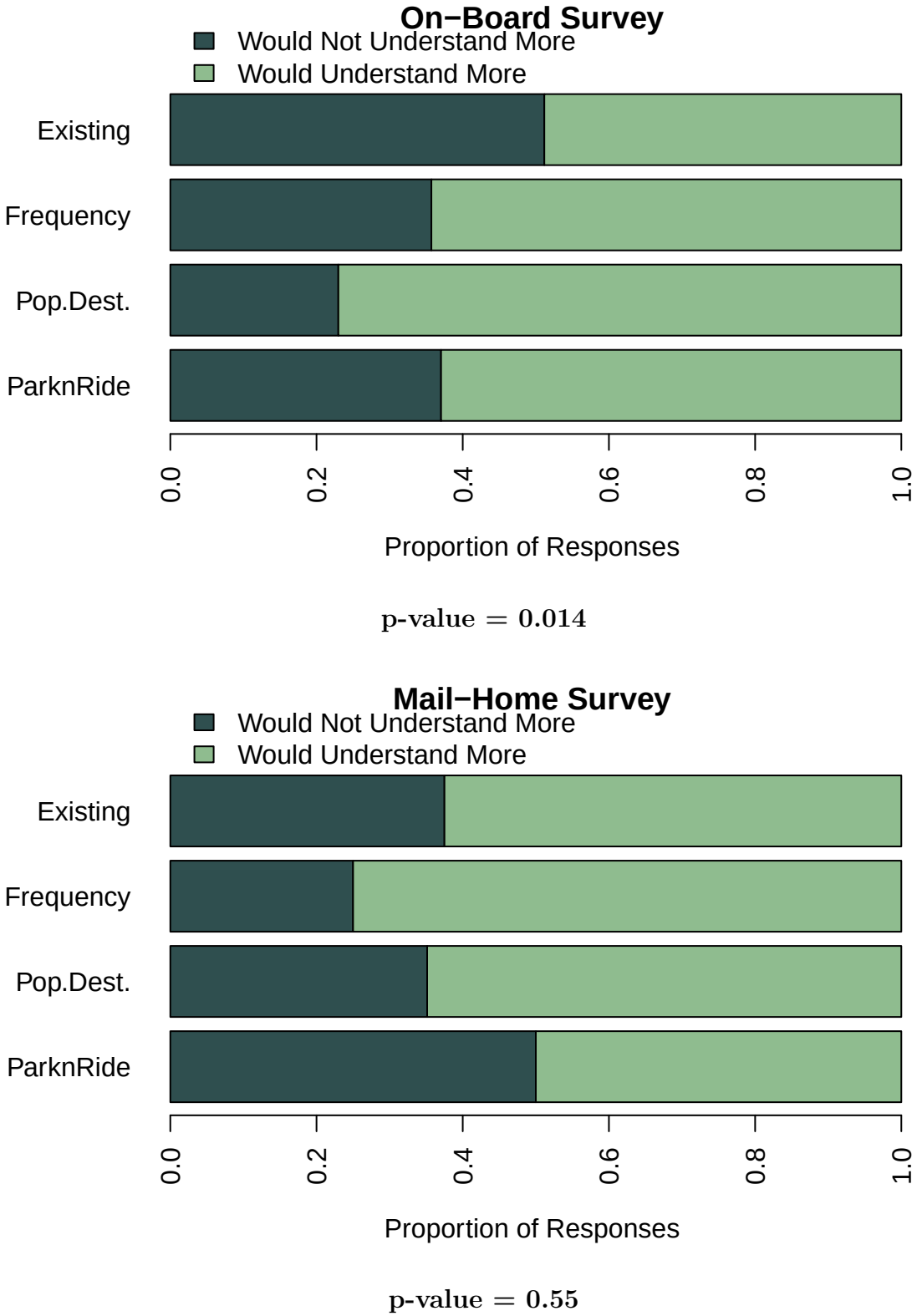


Figure 66: Stated Future Understanding vs. Most Useful Map

the table does not include a p-value.

Table 70: On-Board Survey: Stated Future Understanding vs. Licensure
n = 206
p-value = 0.99

	No License	Licensed.
Would Not Understand More	11	60
Would Understand More	20	115

Table 71: Mail-Home Survey: Stated Future Understanding vs. Licensure
n = 105

	No License	Licensed
Would Not Understand More	2	37
Would Understand More	2	64

In the on-board survey, licensure was insignificant. For the mail-home survey, no conclusions can be made.

8.6 Household Vehicles

Tables 72 and 73 summarize vehicles in the households and how participants responded that their system understanding would change. For both surveys, the chi-square p-value was calculated by combining the households with three and four or more vehicles because of low responses in the four or more category.

The number of household vehicles has no significant impact on whether participants responded that their overall MARTA system understanding would improve or not.

8.7 Ethnicity

Tables 74 and 75 summarize the ethnicities. In the survey, the possible answers were "African American/Black", "Asian", "Middle Eastern", "Jewish", "Hispanic", "Caucasian/White", "Native American", as well as "Unknown", "Others, and "I don't know". These answers were selected so that in other examination of this survey

Table 72: On-Board Survey: Stated Future Understanding vs. Household Vehicles

n = 204

p-value = 0.47

	0	1	2	3	4+
Would Not Understand More	17	32	14	9	0
Would Understand More	26	49	33	15	9

Table 73: Mail-Home Survey: Stated Future Understanding vs. Household Vehicles

n = 105

p-value = 0.51

	0	1	2	3	4+
Would Not Understand More	6	16	12	5	0
Would Understand More	7	25	29	4	1

data, the ethnicity could be compared to credit reporting data. For these surveys, the majority of the responses were "African American/Black", "Asian", and "Caucasian/White". For the on-board survey, all answers besides these three were combined into one "Others" category. In the mail-home survey, "Asian" was included in the "Other" category because of a low number of responses. Some participants did not care to share their ethnicity, or chose not to answer any demographic data. In the ethnicity analysis as well as all demographic analyses, the total number of responses will change depending on the willingness of participants to answer personal questions.

Ethnicity does not have a significant impact on the stated preference response to overall system understanding if these maps were implemented.

8.8 Income

Tables 76 and 77 summarize the income of the participants that were willing to share their household's income for the two surveys.

Income is not a significant factor in the stated preference question of whether participants would better understand the system if these multi-modal maps were implemented. However, it is interesting to note that no majority of any category in

Table 74: On-Board Survey: Stated Future Understanding vs. Ethnicity
n = 203
p-value = 0.42

	Black	Asian	White	Others
Would Not Understand More	39	4	20	8
Would Understand More	82	10	24	16

Table 75: Mail-Home Survey: Stated Future Understanding vs. Ethnicity
n = 101
p-value = 0.24

	Black	White	Others
Would Not Understand More	26	9	3
Would Understand More	33	25	5

Table 76: On-Board Survey: Stated Future Understanding vs. Income
n = 142
p-value = 0.96

	<$30k	$30k-$50k	$50k-$75k	$75k-$100k	$100k+
Would Not Understand More	13	11	9	6	10
Would Understand More	26	26	22	11	17

Table 77: Mail-Home Survey: Stated Future Understanding vs. Income
n = 99
p-value = 0.34

	<$30k	$30k-$50k	$50k-$75k	$75k-$100k	$100k+
Would Not Understand More	15	9	6	2	5
Would Understand More	15	15	13	10	9

either survey stated they would not understand more.

8.9 Family Structure

Tables 78 and 79 summarize the family structures of the participants. Family structure was calculated using the responses to questions asking for the number of adults and children in the household. For the calculation of the p-value for the mail-home survey, both categories with three adults were combined.

The family structure is not significant in whether participants stated they would

Table 78: On-Board Survey: Stated Future Understanding vs. Family Structure
n = 203
p-value = 0.89

	Would Not Understand More	Would Understand More
1 Adult, 0 Kids	20	31
1 Adult, Kid(s)	3	5
2 Adults, 0 Kids	17	33
2 Adults, Kid(s)	15	24
3 Adults, 0 Kids	11	24
3 Adults, Kid(s)	5	15

Table 79: Mail-Home Survey: Stated Future Understanding vs. Family Structure
n = 103
p-value = 0.79

	Would Not Understand More	Would Understand More
1 Adult, 0 Kids	11	18
1 Adult, Kid(s)	3	4
2 Adults, 0 Kids	15	21
2 Adults, Kid(s)	5	15
3 Adults, 0 Kids	1	0
3 Adults, Kid(s)	3	7

better understand the system if these maps were implemented or not.

8.10 Summary

In the on-board and mail-home surveys, 61% and 63% of participants responded that they would understand the overall MARTA system map better if one of these maps was implemented throughout the system.

Table 80 summarizes the chi-square p-values for all of the tested factors.

Unlike the previous two chapters, train ridership, bus ridership, and current transit modes were not significant when examining whether participants stated that they would understand the overall system more or not.

In the on-board survey, the participant's typical train trip purpose and what map they ranked as the most useful had the largest effect on whether they stated that their overall understanding would increase more.

Table 80: Future Bus Ridership Significant Factor Summary

Factor	On-Board Survey chi-square p-value	Mail-Home Survey chi-square p-value
Train Ridership	0.94	0.090
Train Trip Purpose	0.022	0.84
Bus Ridership	0.34	0.37
Bus Trip Purpose	0.18	0.50
Current Transit Modes	0.70	0.57
Most Useful Map	0.014	0.55
Licensure	1.00	NA
Household Vehicles	0.47	0.51
Ethnicity	0.42	0.24
Income	0.96	0.34
Household Structure	0.89	0.79

With regards to the mail-home survey, according to the chi-square tests, no factors were significant. There could have been no significant factors because the mail-home survey samples size was small and a larger sample would have better displayed any patterns. Additionally, there were many categories within each factor that had less than five participants. Because of low response numbers, some categories to be grouped together and also may have affected patterns that would otherwise be detected by a chi-square statistical test.

CHAPTER IX

CONCLUSIONS AND FUTURE RESEARCH

9.1 Conclusions and Findings

The findings from this thesis are important because transit systems are changing. They are becoming more multi-modal to provide better connectivity. As found in these surveys, even with the availability of smartphones and online information, 15% of participants still use paper maps to plan train trips and 29% use them to plan bus trips. For these riders as well as those who use the maps for guidance along the way, multi-modal maps should effectively display transit information regardless of mode.

While it is important to keep in mind the size of the survey sample for this thesis, there are still some important conclusions that can be made. Through personal interaction with the surveyors in the on-board survey and comments from the mail-home survey, these frequency and popular destinations maps were positively received because of how participants ranked the current MARTA rail map and their comments.

In the on-board survey, 54% of participants and 47% in the mail-home survey ranked the current MARTA rail map as the least useful. In comments from the surveys, participants thought that including bus routes with the rail lines was a good idea. In the surveys, participants stated that they "wouldn't have to ask questions" about these transfers and that it "helps me plan trips better". One participant went on to say that "having frequency stated is the key" to making these maps useful so that they can have an expected wait time. These positive responses to multi-modal maps are important because MARTA only produces timetables for large stops on bus routes and riders are left to interpolate when the bus will arrive at their local stop. By including the frequencies, riders would always have a known expected wait time.

One participant stated that he/she "would give the bus a try" since the attractions are shown. All of these positive responses show that providing multi-modal maps is something that is important to riders, especially those that are not experts at riding transit.

One of the main findings was the importance of not only map design, but route and network design. As seen through the participants who thought frequency was the more important attribute but did not rank the frequency map as the most useful, there needs to be frequent service to places where current and potential riders want to go. In the surveys conducted for this thesis, it was clear that there was a disconnect between where the service was and where people wanted to be able to go. Within MARTA, reduced frequencies are largely due to budget cuts in recent years; however agencies should take frequent service to key destinations into consideration when reducing or changing service.

While the disconnect between frequency and popular destinations is not a mapping issue, it raises the point of network design. Although a network, route, or multiple routes interacting may technically provide the most coverage or efficient service if not properly mapped, it may not appear so to transit riders. Especially for choice riders, there needs to be clear, frequent service to the destinations they want/need to get to for them to choose transit over driving. Sometimes finding the routes with the best service and highest frequencies can be difficult when looking at an overall system map that provides a lot of coverage. Providing a map that focuses on the frequenct core of the transit could help riders better navigate and focus on the routes that provide acceptable service to them, especially choice riders. This is important to choice riders because travel times of transit must be competative with those of a personal vehicle for choice riders to select transit.

Even with a disconnect between the frequent bus routes and popular destinations, these multi-modal maps were found to be particularly effective for generating

more bus trips, improving passenger understanding of transit service, and have the opportunity to improve perception of transit service and an agency.

Overall, in the on-board and mail-home surveys respectively, 49% and 25% said that they would ride the bus more in the future if one of these multi-modal maps were implemented. While the more often participants currently ride transit, the more often they responded that they would ride the bus more, this was not always the case. Of participants who currently do not ride the bus at all, 34.4% and 9.4% from the on-board and mail-home surveys respectively said they would ride the bus more if these maps were implemented. It is important to note that the question of future bus ridership is a stated preference question and that it is likely that not all of these people will change their habits [12], but these numbers do indicate the potential to increase bus ridership with better maps and information.

As earlier discussed, many systems have multiple maps to describe rail and bus service which can give the impression that they are separate systems. After viewing these multi-modal maps, the majority of participants stated that their understanding of the overall system would improve. In these surveys, 61% in the on-board survey and 63% in the mail-home survey stated that they would understand the overall MARTA system better. People who are more confident reading transit information materials are more likely to consider taking transit as a transportation option instead of ruling it out completely. Providing both riders and potential riders with maps that are easier to understand would help them orient themselves better in the system and be more open to taking transit in the future.

Something that can be inferred from the potential of more bus trips and better bus map undestanding is improved perception of transit agencies, especially MARTA. MARTA has a limited train system, yet by publicizing the train map more than the bus services provided, it may make the whole system seem limited to some. By adding bus routes, transit riders and non-riders will more easily and clearly see that

more destinations, including popular ones and attractions, are accessible by MARTA without having to sort through either the whole system map or individual route maps, which some riders avoid or may not know where to find.

MARTA's multi-modal map if shown as often and in as many locations as the current rail-only map may show that the current system is more comprehensive than some may think. By increasing bus ridership, popular routes will emerge and may eventually lead to support for expanding the network or upgrading the popular routes.

9.2 Future Research

Looking ahead, there are many future research applications that can come from this thesis. The first would be to perform this mapping survey again knowing that the maps would be implemented and administer a before and after study to see if participants did change their ridership habits on either mode, if their understanding improved, and if their opinion on popular destinations or frequent service remained the same. Additionally, in a future survey, participants should be able to list a primary and secondary trip purpose to get a better idea of how they are using the transit system. A future survey should also ask about participants' willingness to transfer modes and if there is a perceived disutility for transferring.

If the maps were implemented, another study could be done that analyzed ridership changes on the routes included in the multi-modal maps. Examining bus ridership analytically would make the questions about future bus ridership and system map understanding more reliable, as they would be results of what actually happened instead of stated preference questions.

Overall, this thesis was important in gathering rider opinions on multi-modal maps and how these maps could possibly affect interactions with transit and ridership habits. This thesis also opens the door to more detailed studies surrounding implementing these multi-modal maps and guiding transit agencies in what to include on

them and more clearly describe how they are perceived by the public.

9.3 Multi-Modal Map Design Guidelines

Based on the literature and results from multi-modal mapping survey, there are a few important pieces of information that transit agencies should consider when creating these maps. The items listed below are general guidelines. All transit agencies vary in size, ridership, coverage, frequency, operating budget, and how maps are made available.

Frequency is important. The majority of participants in both surveys stated that frequency was important information to include on maps. Based on research, frequency is essential when planning a trip. If the service is frequent (less than ten minutes) then riders tend to not need to check a schedule. They know that they can show up at a stop and that they will not have to wait long. Even in locations where the service is less frequent, knowing the amount of time that riders can expect to wait before the bus comes will take away any mystery as to the bus arrival time. Maps should include an indication of frequency of service, especially as maps become multi-modal.

Destinations to include are not limited to tourist attractions. Ten to fifteen percent of participants stated that their transit trip purposes are shopping and errands. Including these local shopping centers with basic needs and grocery stores are important for the captive transit riders to be aware of and so that potential riders can see how easy it is to access these shopping centers via transit.

Multiple Maps should be created for different sets of riders. For tourists and visitors to a city, an attractions map, similar to that of CTA, should be created and appropriately distributed. Potential locations for these popular destination maps

include the airport, if directly connected to the transit system, as well as hotels and the very attractions that are included on the maps. Providing these to hotels to distribute and encourage transit use could potentially raise ridership among visitors and require the hotels to provide less parking. These maps could also be shown in stations that are in close proximity to the attractions. However, the main map including frequency as well as popular local destinations and shopping centers should be the one provided in trains and stations.

Service in some routes is inconsistent and changes perhaps every other run or according to time of day. These types of routes, or segments of routes, should not be included because they require further explanation for riders. The goal of these maps is to be as easy to understand as possible, and alternating or inconsistent routes could cause more rider confusion.

Service Standards for buses can be more difficult to maintain than for trains that travel on a fixed guideway and do not interact with traffic. However, the bus routes that are added to the general rapid transit map should be held to higher on-time standards and levels of service for passengers so that they are not disappointed if they try taking the buses shown on the map. As mentioned by the MBTA, improving overall service on the bus routes included in their rapid transit map was something they worked towards when creating their multi-modal map.

Street Names should be included where possible. For bus routes that run on one street for the majority of the route, the street name should be shown somewhere along the route. Street name labels do not have to be large and prominent, but it should be there to orient riders as to where the bus does go since the geography is being skewed. There were some participants that commented how helpful it was that "Peachtree Street" and "Buford Highway" labels were included in the maps.

Modes should be differentiated in some way. Transit riders should not be expecting some type of train or rail vehicle to pick them up where there is a local or enhanced bus. Including them all on the same map makes the service and connections clearer to passengers. They should also know what to expect. Unless a bus has its own right-of-way, it will still have to interact with traffic and will not keep the schedule perfectly. The goal of these maps is to equally inform riders of all modes, and have them expect a certain level of service, but still understand that transit systems are systems of multiple modes working together to provide connectivity.

As mentioned before, all transit agencies and maps are different. However, clear mapping of multiple transit modes is important, especially here in Atlanta where more transit development is coming with the addition of the streetcar and the Beltline (light rail). System maps should be created in a way that is easiest to understand for riders and clearly show them all of their options. This thesis is a stepping stone to further how multi-modal maps are created and used in transit agencies.

APPENDIX A

SURVEYS

The surveys were conducted in three different ways. The on-board survey was conducted using tablets and an application developed in house at the Georgia Institute of Technology. Figure 67 shows a screen shot of one of the questions on the tablet.

For the mail-home surveys, there were three mailings in total. The first mailing included a letter with a ussername and password to sign into the online version of the survey. The letter in the original mailing can be seen in Figure 68 and screenshots of the web version of the survey can be seen in Figure 69 and Figure 77.

The second mailing was a postcard with the username and password included as a reminder for participants to complete the survey. The postcard can be seen in Figures 71 and 72.

The third and final mailing contained a letter as well as the four-page paper survey and the four maps used in the mapping question section. These can be seen in Figures 73 through 81

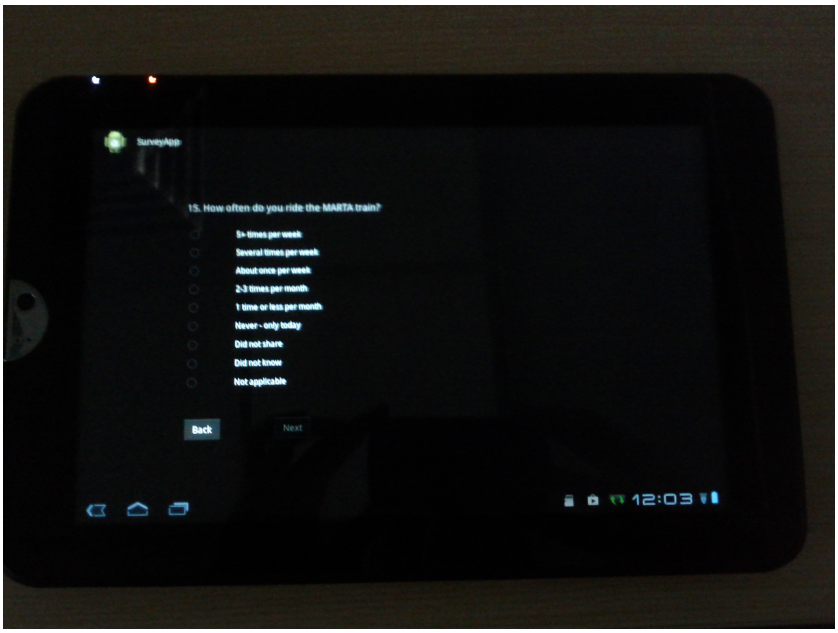
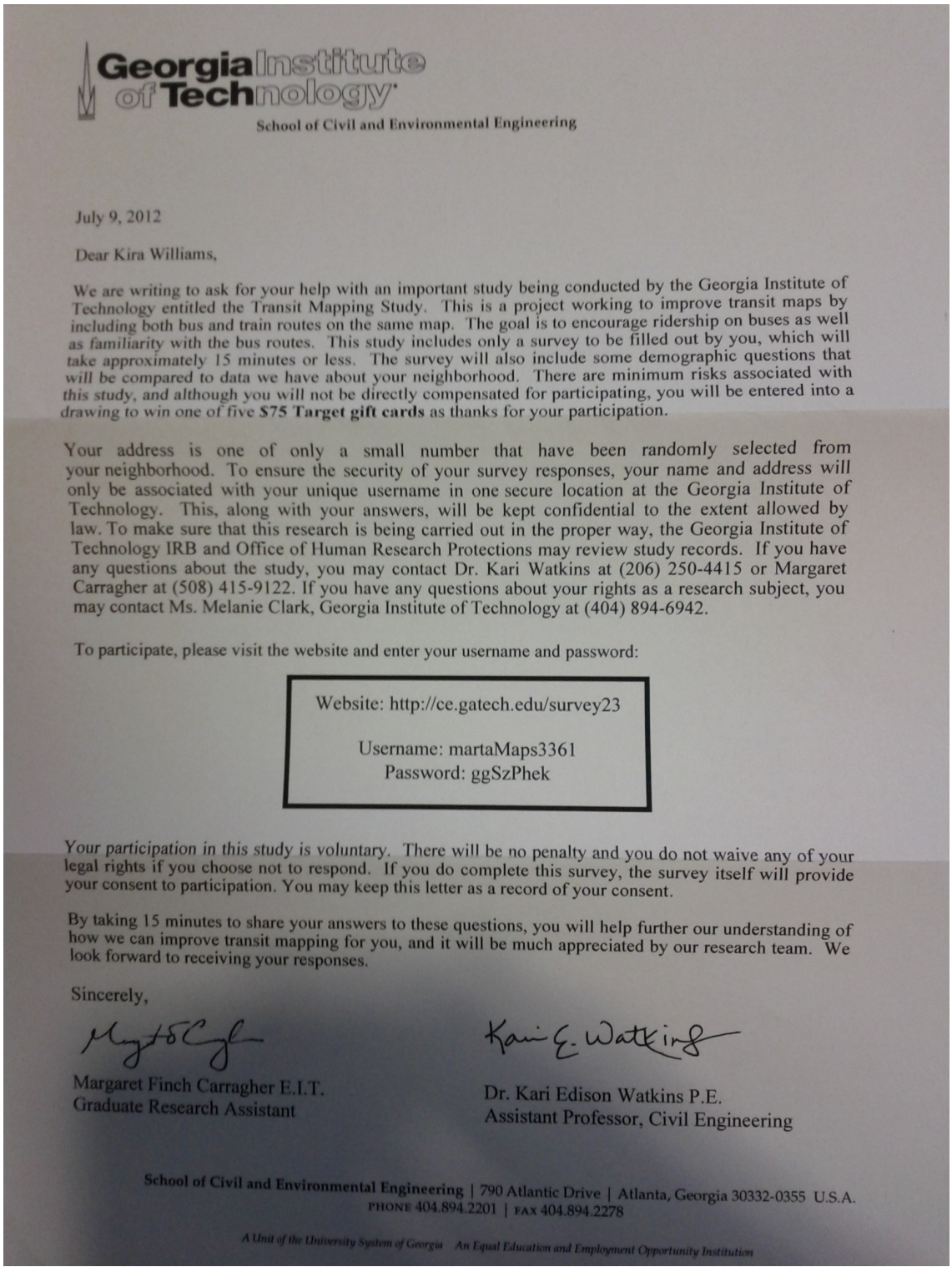


Figure 67: Tablet Question Screenshot
Source: WMATA, 2012



Georgia Institute of Technology

School of Civil and Environmental Engineering

July 9, 2012

Dear Kira Williams,

We are writing to ask for your help with an important study being conducted by the Georgia Institute of Technology entitled the Transit Mapping Study. This is a project working to improve transit maps by including both bus and train routes on the same map. The goal is to encourage ridership on buses as well as familiarity with the bus routes. This study includes only a survey to be filled out by you, which will take approximately 15 minutes or less. The survey will also include some demographic questions that will be compared to data we have about your neighborhood. There are minimum risks associated with this study, and although you will not be directly compensated for participating, you will be entered into a drawing to win one of five **$75 Target gift cards** as thanks for your participation.

Your address is one of only a small number that have been randomly selected from your neighborhood. To ensure the security of your survey responses, your name and address will only be associated with your unique username in one secure location at the Georgia Institute of Technology. This, along with your answers, will be kept confidential to the extent allowed by law. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB and Office of Human Research Protections may review study records. If you have any questions about the study, you may contact Dr. Kari Watkins at (206) 250-4415 or Margaret Carragher at (508) 415-9122. If you have any questions about your rights as a research subject, you may contact Ms. Melanie Clark, Georgia Institute of Technology at (404) 894-6942.

To participate, please visit the website and enter your username and password:

Website: http://ce.gatech.edu/survey23

Username: martaMaps3361
Password: ggSzPhek

Your participation in this study is voluntary. There will be no penalty and you do not waive any of your legal rights if you choose not to respond. If you do complete this survey, the survey itself will provide your consent to participation. You may keep this letter as a record of your consent.

By taking 15 minutes to share your answers to these questions, you will help further our understanding of how we can improve transit mapping for you, and it will be much appreciated by our research team. We look forward to receiving your responses.

Sincerely,

Margaret Finch Carragher E.I.T.
Graduate Research Assistant

Dr. Kari Edison Watkins P.E.
Assistant Professor, Civil Engineering

School of Civil and Environmental Engineering | 790 Atlantic Drive | Atlanta, Georgia 30332-0355 U.S.A.
PHONE 404.894.2201 | FAX 404.894.2278

Figure 68: First Mailing Accompanying Letter

Figure 69: Web Survey Introduction Screenshot

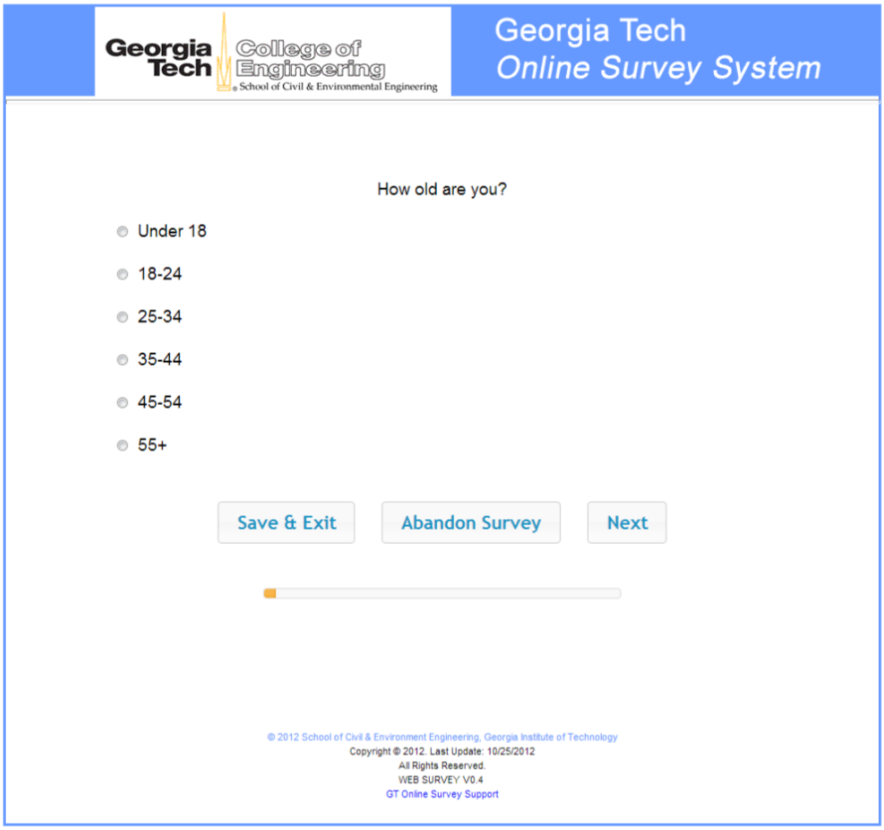


Figure 70: Web Survey Question Screenshot

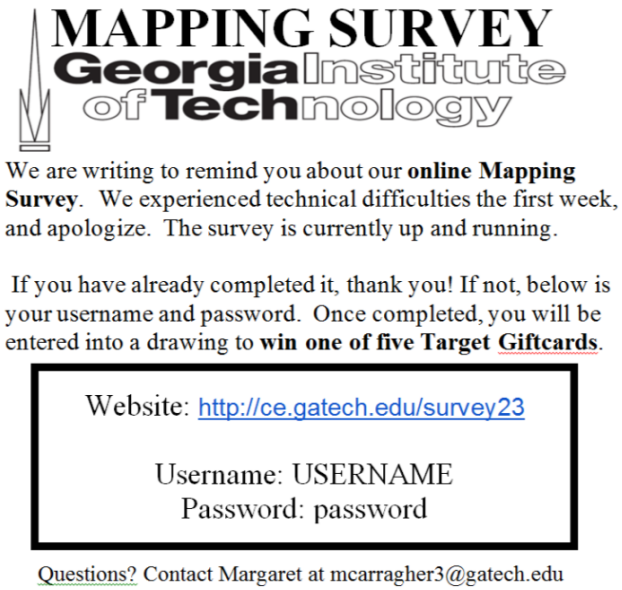


Figure 71: Second Mailing Postcard (Front)

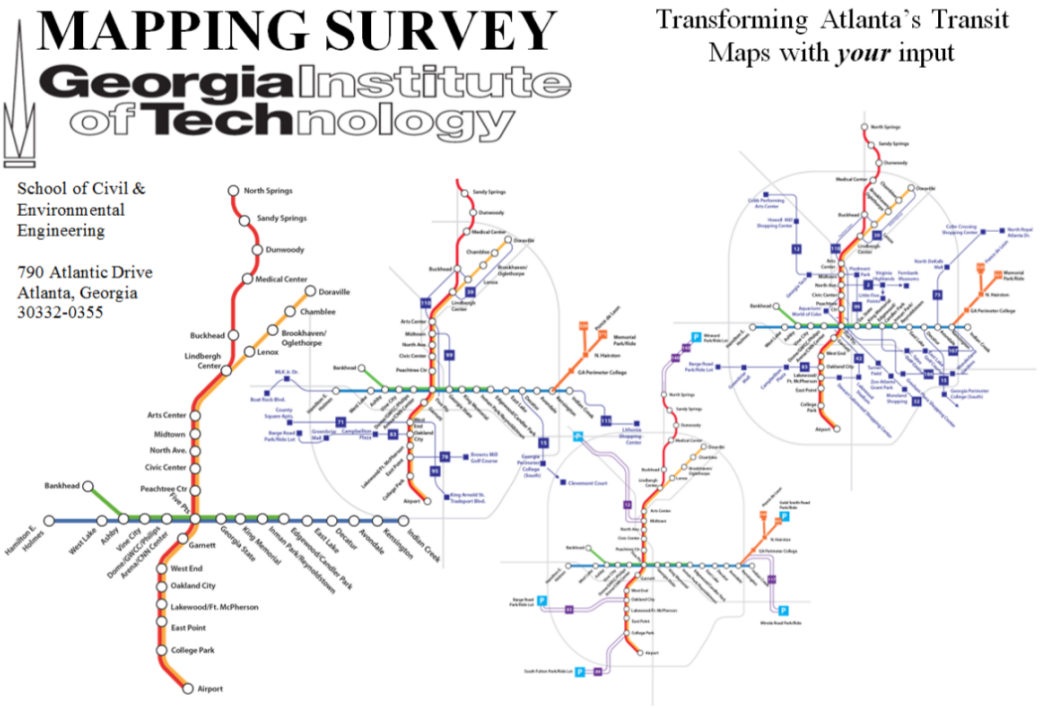


Figure 72: Second Mailing Postcard (Back)

November 2, 2012

Dear Pamela Watkins,

We are writing to ask for your help with an important study being conducted by the Georgia Institute of Technology entitled the Transit Mapping Study. Through this project we are working to improve transit maps by including both bus and train routes on the same map.

We previously sent you a link to an online website, but have included a paper copy here for your convenience. This packet includes a survey which will take about 10 minutes or less. The survey asks for your opinions on these new maps and some demographic questions that will be compared to data we have about your neighborhood. Your address is one of only a small number that have been randomly selected from your neighborhood. There are minimum risks associated with this study, and as a reward for your participation, you will be entered into a drawing to win one of five **$75 Target Gift Cards**.

To ensure the security of your survey responses, your name and address will only be associated with your unique username in one secure location at the Georgia Institute of Technology. This, along with your answers, will be kept confidential to the extent allowed by law.

To participate, please fill out the attached survey. Once you have finished it, please fold it shut, tape the open end, and put it in the mail. The survey is preaddressed to us and the tape is included. Once we receive it, we will enter you into the drawing for a **$75 Target Gift Card.**

As a reminder, your participation in this study is voluntary and there will be no penalty nor do you waive any legal rights by participation. If you do choose to complete the survey, the survey itself will serve as your consent. To ensure the survey is being properly carried out, the Georgia Institute of Technology IRB and Office of Human Research Protections may review study records. If you have any questions about the study, you may contact Dr. Kari Watkins at (206) 250-4415 or Margaret Carragher at (508) 415-9122. If you have any questions about your rights as a research subject, you may contact Ms. Melanie Clark at (404) 894-6942.

By taking 10 minutes to share your answers to these questions, you will help further our understanding of how we can improve transit mapping for you, and it will be extremely appreciated by our research team. We look forward to receiving your responses.

Sincerely,

Margaret Finch Carragher E.I.T.
Graduate Research Assistant

Dr. Kari Edison Watkins P.E.
Assistant Professor, Civil Engineering

Figure 73: Third Mailing Letter

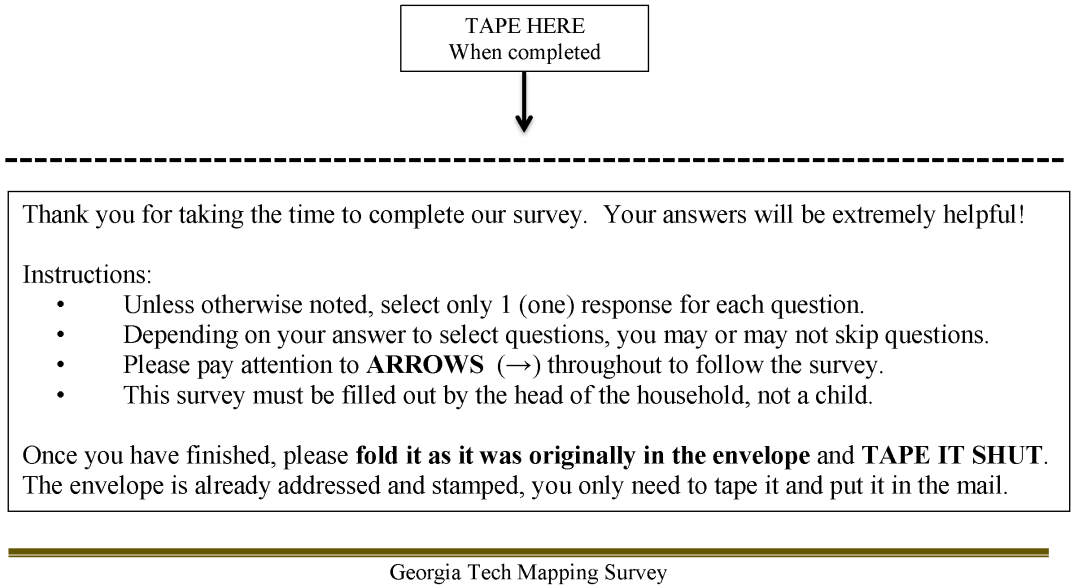


Figure 74: Web Survey Question Screenshot

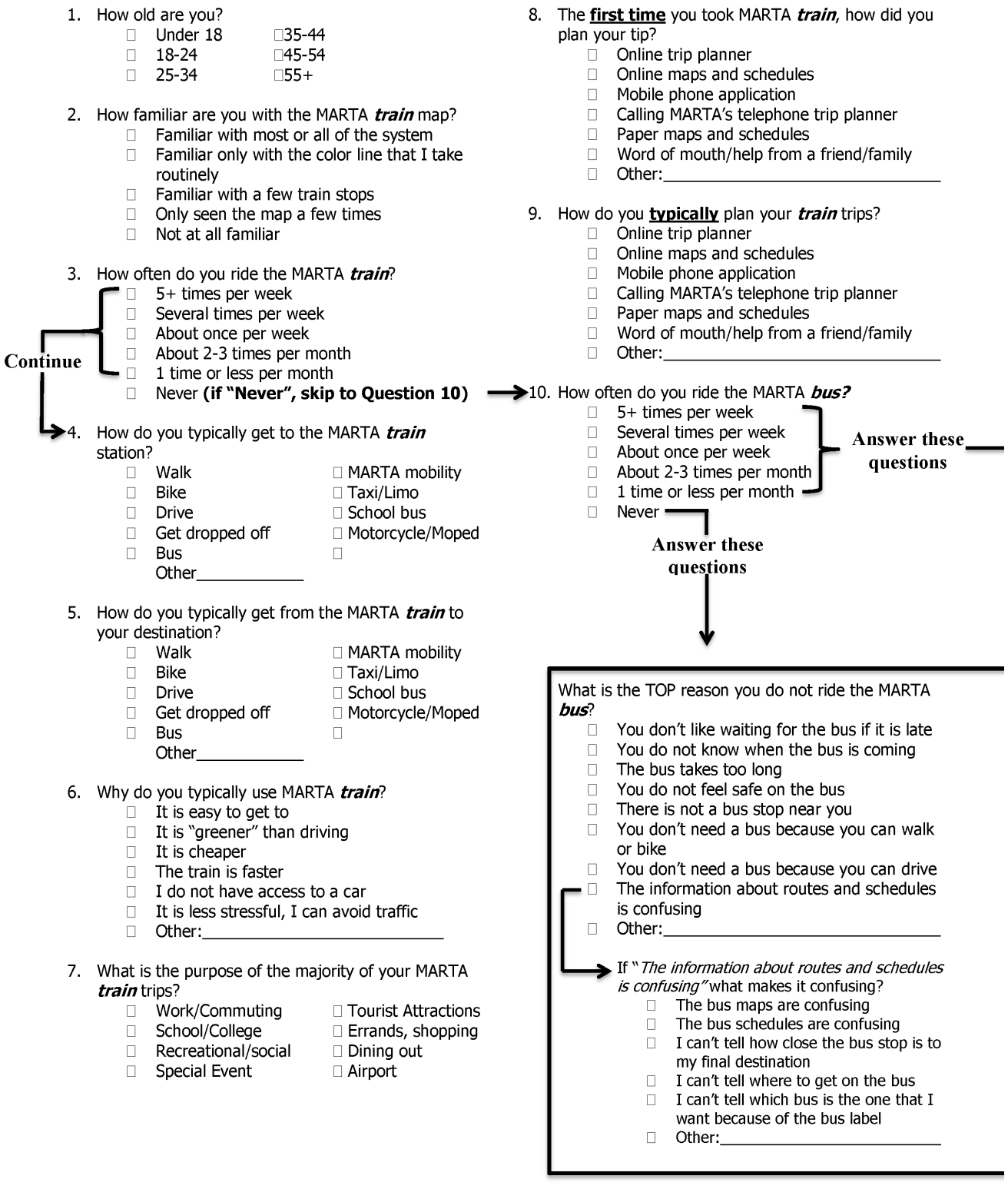


Figure 75: Web Survey Question Screenshot

What is the main reason you use MARTA ***bus***?

- ☐ It is easy to get to
- ☐ It is "greener" than driving
- ☐ It is cheaper
- ☐ The train is faster
- ☐ I do not have access to a car
- ☐ It is less stressful, I can avoid traffic
- ☐ Other:_____

What is the purpose of the majority of your ***bus*** trips?

- ☐ Work/Commuting
- ☐ School/College
- ☐ Recreational/social
- ☐ Special Event
- ☐ Tourist Attractions
- ☐ Errands, shopping
- ☐ Dining out
- ☐ Airport

How do you typically plan your ***bus*** trips?

- ☐ Online trip planner
- ☐ Online maps and schedules
- ☐ Mobile phone application
- ☐ Calling MARTA's telephone trip planner
- ☐ Paper maps and schedules
- ☐ Word of mouth/help from a friend/family
- ☐ Other_____

How do you typically get to the ***bus***?

- ☐ Walk
- ☐ Bike
- ☐ Drive
- ☐ Get dropped off
- ☐ Bus
- ☐ MARTA mobility
- ☐ Taxi/Limo
- ☐ School bus
- ☐ Motorcycle/Moped
- ☐ Other_____

Continue to Question 11

What are other reasons you do not ride the MARTA ***bus***? **(you may select more than 1)**

- ☐ Information about routes & schedules is confusing
- ☐ You don't like waiting for the bus if it is late
- ☐ You do not know when the bus is coming
- ☐ The bus takes too long
- ☐ You do not feel safe on the bus
- ☐ There is not a bus stop near you
- ☐ You don't need a bus because you can walk or bike
- ☐ You don't need a bus because you drive
- ☐ Other:_____

If you had to plan a ***bus*** trip, how would you do it?

- ☐ Online trip planner
- ☐ Online maps and schedules
- ☐ Mobile phone application
- ☐ Calling MARTA's telephone trip planner
- ☐ Paper maps and schedules
- ☐ Word of mouth/help from a friend/family
- ☐ Other:_____

Continue to Question 11

11. What is the TOP improvement that would encourage you to use the ***bus*** more often?
    - ☐ If I felt safer on the bus
    - ☐ If I could understand the maps better
    - ☐ If I could understand the schedule better
    - ☐ If I knew when the bus was coming
    - ☐ If the bus came more often
    - ☐ If the bus went where I need to go
    - ☐ Other:_____
12. What are other improvements that would encourage you to use the bus more often? **(you may select more than 1)**
    - ☐ If I felt safer on the bus
    - ☐ If I could understand the maps better
    - ☐ If I could understand the schedule better
    - ☐ If I knew when the bus was coming
    - ☐ If the bus came more often
    - ☐ If the bus went where I need to go
    - ☐ Other:_____
13. How do you travel most?
    - ☐ Walk
    - ☐ Bike
    - ☐ Drive
    - ☐ Get dropped off
    - ☐ Bus
    - ☐ MARTA mobility
    - ☐ Taxi/Limo
    - ☐ School bus
    - ☐ Motorcycle/Moped
    - ☐ Other_____

Questions 14-21 involve the maps that are attached to this packet. They are labeled Map A-Map D

14. Is it more important for the maps to show the bus routes that reach popular destinations or buses that come often?
    - ☐ Popular destinations
    - ☐ Buses that come often
15. Which of the above maps would be the best for when/where you need to go?
    - ☐ A: Park and Ride Map
    - ☐ B: Attractions Map
    - ☐ C: 20 Minutes All Day Map
    - ☐ D: Current MARTA Map
16. Rank these maps in order with 1 being the **easiest to read** and 4 being the **most difficult** to read?
    - _____A: Park and Ride Map
    - _____B: Attractions Map
    - _____C: 20 Minutes All Day Map
    - _____D: Current MARTA Map

Why did you rank the maps this way?

_____
_____
_____
_____
_____
_____

Figure 76: Web Survey Question Screenshot

17. Rank these maps in order with 1 being the **most useful** and 4 being the **least useful**?
    _____A: Park and Ride Map
    _____B: Attractions Map
    _____C: 20 Minutes All Day Map
    _____D: Current MARTA Map

    Why did you rank the maps this way?
    _____
    _____
    _____
    _____
    _____
    _____
    _____

18. What are the noticeable differences compared to the existing MARTA map?
    _____
    _____
    _____
    _____
    _____
    _____
    _____
    _____

19. Do any of these maps affect routes where you could possibly travel?
    ☐ Yes ☐ No
    Which one(s)_____

20. If one of these maps replaced the current MARTA overall map, would you ***ride the bus more***?
    ☐ Yes ☐ No
    Why?
    _____
    _____
    _____
    _____
    _____
    _____
    _____
    _____

21. If one of these maps replaced the current MARTA overall map would it help your understanding of the overall MARTA system?
    ☐ Yes ☐ No
    Why?
    _____
    _____
    _____
    _____
    _____
    _____

The following questions are about your household.

22. How many vehicles does your household own?
    ☐ 0 ☐ 3
    ☐ 1 ☐ 4+
    ☐ 2

23. What is your gender?
    ☐ Female ☐ Male

24. How many adults (18+) are in your household?
    ☐ 1 ☐ 4
    ☐ 2 ☐ 5
    ☐ 3 ☐ 6+

25. How many children (under 18) are in your household?
    ☐ 1 ☐ 4
    ☐ 2 ☐ 5
    ☐ 3 ☐ 6+

26. What is your marital status?
    ☐ Single ☐ Married

27. What is the age of the head of your household?
    _____

28. Do you have a driver's license?
    ☐ Yes ☐ No

29. What ethnic group do you identify with?
    ☐ African American/Black
    ☐ Asian ☐ Caucasian/White
    ☐ Middle Eastern ☐ Native American
    ☐ Jewish ☐ Unknown
    ☐ Hispanic ☐ Other

30. Is this household…
    ☐ Owned by you or someone in the household with a mortgage or a loan?
    ☐ Owned by you or someone in the household free and clear without a mortgage or loan?
    ☐ Rented?

31. What is the highest degree or level of school you have completed? If currently enrolled, mark the previous grade or highest degree received.
    ☐ Some high school or less
    ☐ High school completed
    ☐ Some college
    ☐ College completed
    ☐ Graduate school

32. What is the total annual income of your household
    ☐ Less than $30,000
    ☐ $30,000-$49,999
    ☐ $50,000-$74,999
    ☐ $75,000-$99,999
    ☐ $100,000 or higher

Figure 77: Web Survey Question Screenshot

These maps are yours to keep. Please pull them out when you answer the questions and do not mail them back.

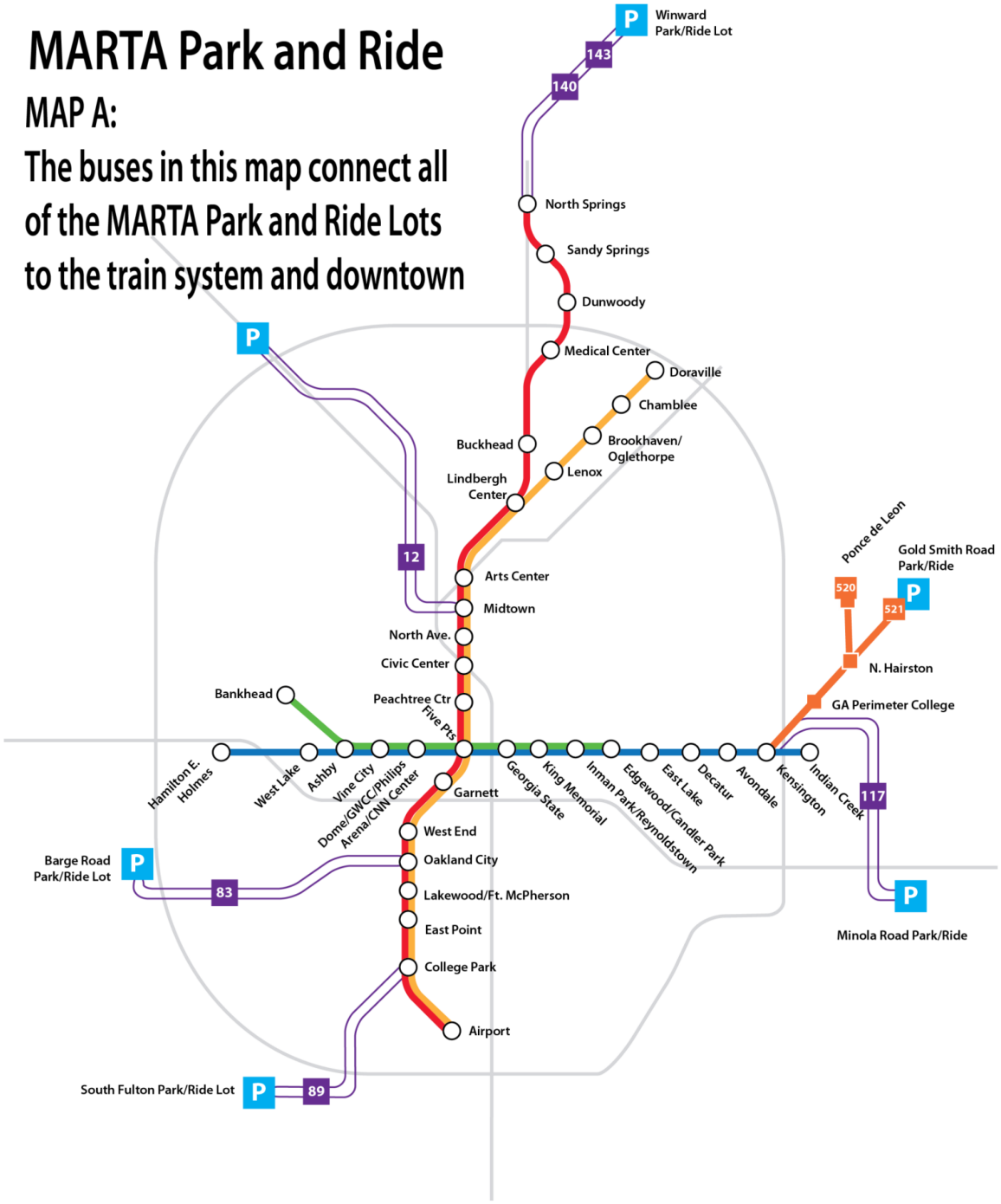


Figure 78: Park and Ride Map

These maps are yours to keep. Please pull them out when you answer the questions and do not mail them back.

Figure 79: Popular Destinations Map

These maps are yours to keep. Please pull them out when you answer the questions and do not mail them back.

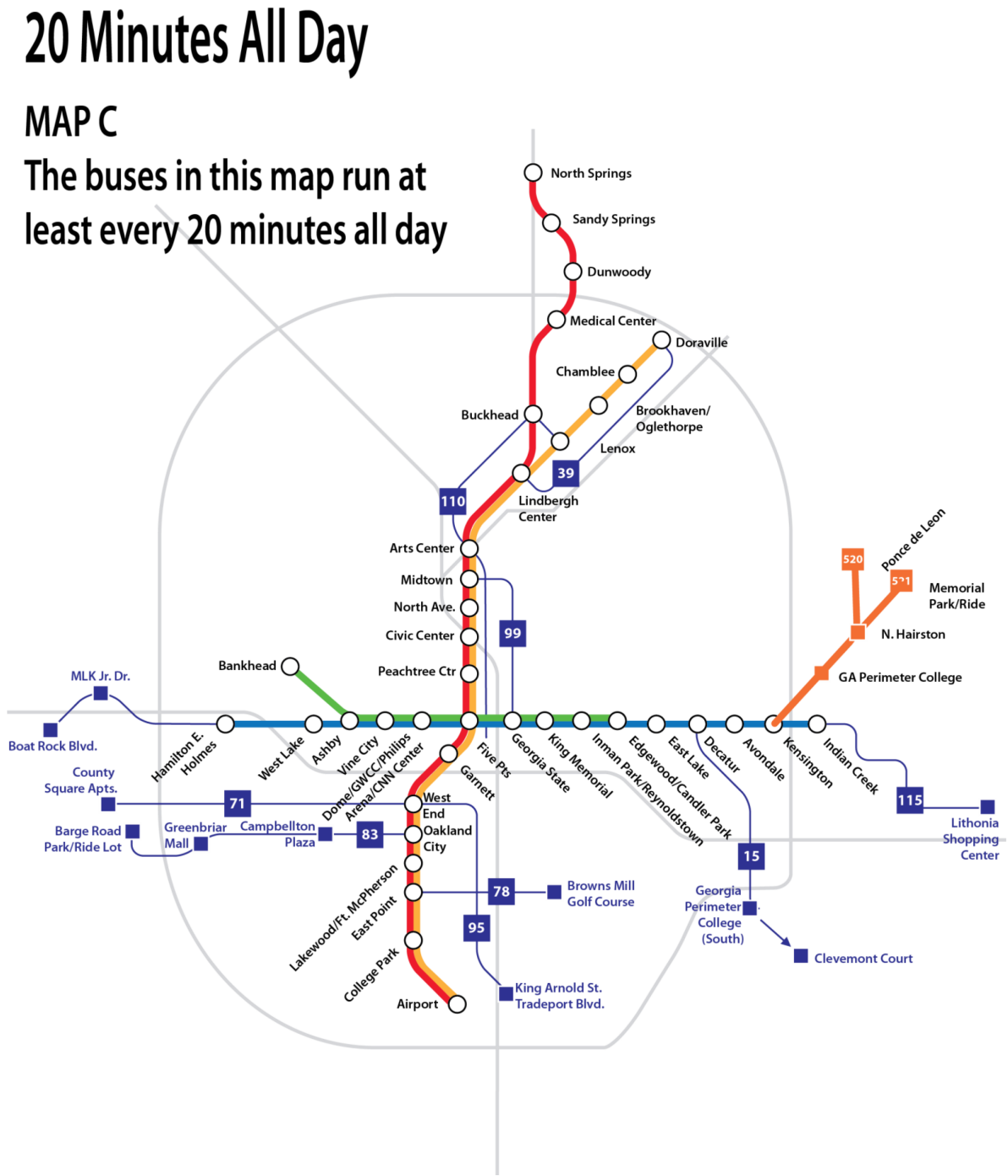


Figure 80: Frequent Service Map

These maps are yours to keep. Please pull them out when you answer the questions and do not mail them back.

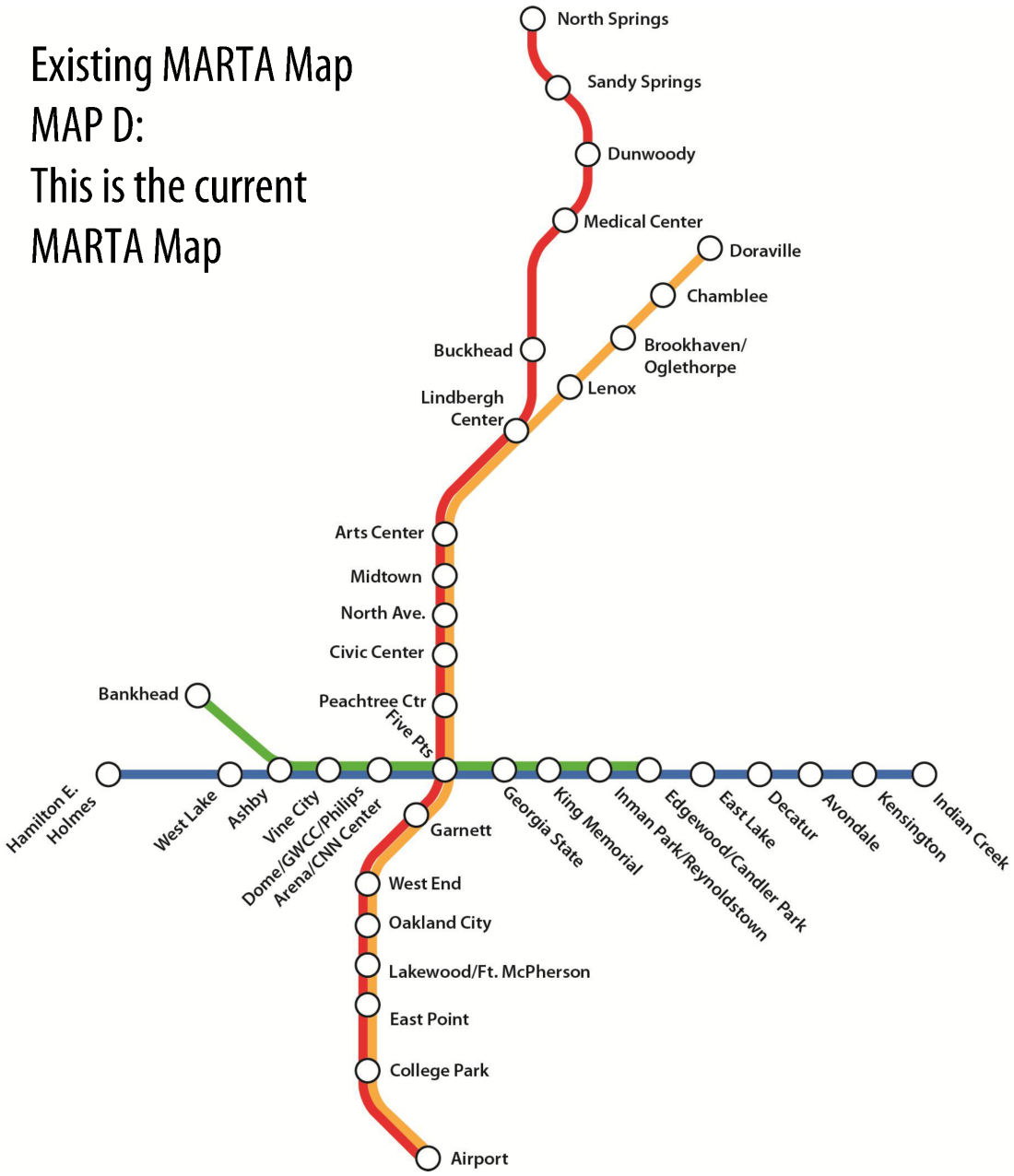


Figure 81: Existing Map

APPENDIX B

IRB ACCEPTED APPLICATION

The accepted IRB application is included in the following 18 pages.

Protocol H12104 As Of: February 12, 2013 05:18 PM

Title: MARTA Transit Mapping Project

Principal Investigator: Kari Edison Watkins

Admin Assigned: Melanie Clark

Committee Assigned: Central Institutional Review Board #1

Review Type: Exempt Review

Current Status: Approved

Last Activity: 04/13/2012 - Consent Procedures Approved

Original Approval Start: 04/13/2012

Current Approval Period: 04/13/2012 - Indefinite

Protocol Details | Related Submissions

Protocol Description:

The goal of this project is to determine whether the design of a map and inclusion of bus routes on a transit system map impacts bus ridership. The researcher has developed new maps for the MARTA system that include bus and train routes. Two surveys will be conducted to determine the potential bus ridership, should these new maps be implemented and posted throughout the internet, bus, and train stations. One survey will be an on-board survey on MARTA train targeting train riders who do not use the bus and why they use only the train and not the bus, as well as their reaction to the new bus/train maps. The second survey will target neighborhoods within walking distance to a bus stop, but not walking distance to a train station. The goal of this survey is to determine whether people know that they are close to a bus stop and whether or not they utilize it. If they do not, the survey asks about reasons why they do not use the bus and whether inclusion of their route on an overall map would increase their ridership on the bus. The results of these surveys will show whether or not there is a relationship between map design and bus ridership as well as reasons why people do not utilize public bus transportation. A secondary goal is to compare the demographic data with the targeted marketing data to see if it is accurate and if there is any bias in the data.

Department:

Transportn

Research Personnel:

Name	Role	Certification	Documents
Kari Edison Watkins	PI	• Georgia Tech CITI Human Subjects Training Certification (Approved): September 6, 2011 - September 6, 2014 >> ! This certification may expire before the protocol !	
Aaron I Gooze	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): February 28, 2012 - February 28, 2015 >> ! This certification may expire before the protocol !	
Alex Joshua Poznanski	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): November 3, 2011 - November 3, 2014 >> ! This certification may expire before the protocol !	

Figure 82: IRB Application Page 1/18

Amanda Inez Wall	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): February 20, 2012 - February 20, 2015 >> ! This certification may expire before the protocol !
Brian Christopher Maddox	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): February 20, 2012 - February 20, 2015 >> ! This certification may expire before the protocol !
James Christopher Wong	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): November 3, 2011 - November 3, 2014 >> ! This certification may expire before the protocol !
Joel David Anders	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): November 15, 2010 - November 15, 2013 >> ! This certification may expire before the protocol !
Josephine Denise Kressner	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): April 26, 2010 - April 26, 2013 >> ! This certification may expire before the protocol !
Maria Nicole Roell	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): July 8, 2011 - July 8, 2014 >> ! This certification may expire before the protocol !
Melody Nicole Butler	Student	• Georgia Tech CITI Human Subjects Training Certification (Approved): October 19, 2011 - October 19, 2014 >> ! This certification may expire before the protocol !
Margaret Finch Carragher	Co-Investigator	• Georgia Tech CITI Human Subjects Training Certification (Approved): October 21, 2011 - October 21, 2014 >> ! This certification may expire before the protocol !

The Protocol: Research Design and Methodology

A * required * Human Subjects Training is a requirement for approval. Have you completed Human Subjects Training? PLEASE NOTE: YOU CAN SUBMIT THE IRB APPLICATION PRIOR TO COMPLETION OF THE TRAINING, HOWEVER, APPROVAL WILL NOT BE ISSUED UNTIL TRAINING HAS BEEN COMPLETED AND THE OFFICE OF RESEARCH COMPLIANCE HAS YOUR TRAINING ON FILE. If you have not completed training you will find instructions on how to do so here PLEASE SAVE YOUR APPLICATION BEFORE CLICKING ON THE LINK AS YOU WILL BE TAKEN OUT OF IRBWISE AND ANY INFORMATION YOU HAVE ENTERED WILL BE LOST IF YOU DO NOT SAVE IT BEFORE LEAVING.

yes

B Describe in lay terms the purpose of the research. State what you hope to learn or prove. This section should not include scientific methodology or language. It should be easily understood by a lay person who has little or no expertise in your area of research.

Figure 83: IRB Application Page 2/18

The purpose of this research is to determine the impact that map design has on the choice of people to either drive, take the train, or take the bus. More specifically, this research will create MARTA system maps that include both the train routes and selected bus routes and conduct a survey to determine if this inclusion of bus routes on the map would encourage bus ridership. With this information, this project will also develop methodologies and criteria for creating similar maps that include trains and buses in other cities to encourage bus ridership in other cities as well. The secondary purpose is to determine how accurate targeted marketing data is with regards to demographic data.

c State the Inclusion/Exclusion Criteria. For example, a survey about attitudes regarding education outside of the United States might have these inclusion criteria: Only those persons who are 18 years of age and older and who have attended one full academic year of secondary education outside of the United States are eligible to participate. For a study comparing two sports drinks to be used by athletes, persons who seldom exercise, have heart disease or hypertension, or are above a certain age might be excluded from participation.

There are two parts to this survey. The mail-home survey will be sent randomly to households located in the specified neighborhoods with no restrictions on which households will be selected. With regards to the on-board MARTA train survey, no one under 18 will be interviewed. Upon approaching someone, the first question will be age to ensure that the interviewees are at least 18 years of age.

Funding:

Type: External

Funding Source	Grant Title	ICOL # (Doc ID)
US DOT Research and Innovative Technology Administration	University Transportation Center	104281

Research Locations:

Short Name	Full Name
East Lake	East Lake Neighborhood
Pine Lake	Pine Lake Neighborhood
Pomona Lake	Pomona Lake Neighborhood
MARTA	MARTA Trains, All Stations

Human Subject Interaction:

Will the research involve direct interaction with subjects?

Yes

Number of Subjects for this Protocol

Figure 84: IRB Application Page 3/18

3000

Gender of Subjects for this Protocol

Both genders

Vulnerable Populations:

Group Names

Normal Volunteers

Educationally disadvantaged

Economically disadvantaged

Subjects, Inclusion, and Exclusion Criteria

A Total number of subjects to be enrolled in the study. Include justification. For clinical protocols, it is important to scientifically justify the number of participants needed and to state a precise number to be enrolled. For non-clinical and minimal risk studies, participant numbers may be stated as a range, (i.e.: 100-500. We will mail surveys to 500 addresses and hope to have responses from 100 participants). If responses are received from more than 100 participants, you will not have over-enrolled. Web-enabled recruitment may result in far more responses than anticipated or needed. If the number of participants has been stated as a range (Up to 1000), over-enrollment is less likely. You should be prepared to shut down a web recruitment site immediately if responses exceed the number of approved participants. Over-enrollment must be reported to the IRB as a protocol violation or deviation, and it may be unethical to accept responses from participants whose data are not needed and will not be utilized.

For the on-board survey, we will survey 400 participants. This number is statistically significant at the 5% confidence level. Once 400 on-board surveys have been completed, the data will be checked to ensure that there are at least 35 responses in each answer category to ensure statistical significance. If this requirement has not been met, surveys will continue to be administered randomly until they have met requirements. For the mail-back survey, we will send out 1500 surveys. We anticipate a response rate between 20 - 30%. This will give us 400 - 500 responses, enough for statistical significance as outlined above.

B Expected number of subjects to be enrolled per year:

(No Answer Given)

C Expected number of years study will be active.

1

D State the duration of subject participation. How many hours? Days? Over what period of weeks or months?

Figure 85: IRB Application Page 4/18

The time commitment is 10-15 minute survey conducted in person, via mail, or internet.

E Federal regulations require that non-pregnant women be included in research unless their exclusion can be scientifically justified. Are you including women who are not pregnant?

Yes

F If you marked OTHER above, please provide the justification for excluding non-pregnant women:

(No Answer Given)

G If you are excluding minors, please state the scientific justification below. For example, "This study of Alzheimer's patients excludes minors, as that population is not known to have the disease." Or, "This study will examine driving records of over-the-road truckers who drive at least 250,000 miles annually. That population does not include minors."

(No Answer Given)

H * required * Provide detail of steps to be taken to ensure additional protection of the rights and welfare of the identified vulnerable population.

The names of the participants on the on-board survey will not be asked. They will be asked a general origin location, but not a specific address. For those that are involved in the mail/internet study, if they mail it back, there will be no name/address to identify them by. If they complete it online, there will be no questions asked that could identify them.

Recruitment & Compensation

A Describe in detail the recruitment plan. Who will be recruited and how? By recruitment ads, word of mouth, email? If by word of mouth, PROVIDE A BRIEF SCRIPT. The IRB does not expect the script to be followed verbatim; however, the recruitment language must be reviewed. If using flyers, email, advertisements, screen shots from websites, or other documents, submit copies with this protocol.

(No Answer Given)

B Is a Georgia Tech Student Subject Pool being used? NOTE: Only the School of Psychology and the College of Management have formal Student Subject Pools. In order to recruit from among either group, advance arrangements must be made with the manager of that pool.

No

C Will subjects be compensated for participation? If yes, provide details of remuneration, i.e.: total amount of money for completion of study and prorated amounts if study is not completed. If compensation will be class credit, state number of hours of credit to be granted for completion of study, and include plans for prorating credit if study is not completed.

Figure 86: IRB Application Page 5/18

(No Answer Given)

Clinical Trials

A Will the data contain any information that could personally link the subject to the research?

Yes

B If Social Security numbers or other identifiers will be collected, state how those will be kept confidential. How will they be stored? Where will the linking key or code be safeguarded? Who will have access?

The households that will receive a questionnaire in the mail-home survey will be randomly sampled from the targeted marketing data, which is a dataset available for purchase by the public. This data will contain names, addresses, and reported demographic data about each household. In order to maintain confidentiality when linking this targeted marketing data to the survey responses, the following steps will be taken. The targeted marketing data will begin with name, address, census block, and demographic data (file 1). From this file, the name and address will be removed and replaced with a unique identifier (file 2). The file with the name, address, and unique identifier (file 3), along with file 1, will be stored in a secure, separate location immediately after the surveys are mailed out. Only three people will have access to this secure location including Margaret Carragher (Master's student), Josephine Kressner (PhD student), and Dr. Kari Watkins. When the survey responses are compiled, only the unique identifier will be available and included with the responses (file 4). These survey responses will be linked via the unique identifier to file 2, which will only have the household's location at the census block level.

C Will data be reviewed by a Data Safety Monitoring Board? (DSMBs generally monitor results of clinical trials for trends or unanticipated adverse events. For example, if adverse events of a similar nature begin to occur, the DSMB will call this to the attention of the investigators. In extreme cases, the study may need to be modified or even halted).

No

Research Subject to the Health Insurance Portability & Accountability Act (HIPAA)

A * required * Does this research involve the collection of health information? (Health information includes physical or mental information regarding the diagnosis, treatment and/or prevention of physical or mental conditions of the type that is now, or could be in the future, covered by health insurance.)

No

B If applicable, please check all of the following that will be collected by this research:

(No Answer Given)

Figure 87: IRB Application Page 6/18

C If the proposed activity is for research in which subject authorization will not be obtained, please check the appropriate answer:

(No Answer Given)

Biological Specimens and/or Genetic Testing

A Has Environmental Health & Safety approval been obtained for the proposed work with biological specimens? Upload the approval letter here.

The Office of Environmental Health & Safety can be reached at 404.894.6120.

(No Answer Given)

B Do the biological specimens currently exist, or will specimens be collected prospectively?

(No Answer Given)

C Are the biological specimens identified or de-identified?

(If the research team has access to a code linking identities to specimens, specimens are identifiable.

If a code exists and is in the possession of others NOT on the research team, AND if a Data Use Agreement is in place specifying that identifiers never be provided to the research team, the specimens are consider de-identified).

(No Answer Given)

D What type of specimens have been or will be collected? How will they be used and stored? If specimens will be banked for future use, identify the biobank and state who will have access.

The informed consent process must provide for separate consent for the collection and banking of these samples.

A consent template for this purpose may be found in the appendices of the Policies and Procedures located at www.researchintegrity.gatech.edu. Click on Institutional Review Board, then select Policies and Procedures.

(No Answer Given)

E If this study will involve genetic research, describe below the type of genetic research to be performed.

If researchers will potentially discover genetic information that may be of concern to subjects, discuss how this will be handled. Consider whether this information should be offered to subjects. Will the consent document disclose that such a discovery may occur? Should subjects

Figure 88: IRB Application Page 7/18

be asked during the consent process whether they want to be informed about such information?

(No Answer Given)

F If biological specimens will be imported from outside of the United States, approval from the Centers for Disease Control may be required and other regulations may also apply. Indicate here whether biological specimens will come from outside of the United States and, if so, specify the source, including name, entity, and international address. Upload any approvals from CDC or other agencies.

(No Answer Given)

Data Management

A Describe the plan to ensure that the data collected will directly address the research questions, and indicate the frequency with which data will be monitored.

(No Answer Given)

B Describe procedures for maintaining confidentiality of the data to be collected or received. Describe how the data will be safeguarded from access by those not authorized. How will data be transmitted among research personnel? Where relevant, discuss the potential for deductive disclosure (i.e., directly identifying subjects from a combination of indirect identifiers).

(No Answer Given)

C If a key/code linking to subject identities exists, state how it will be safeguarded and who will have access to that linking information.

(No Answer Given)

D Check all of the following that will be utilized to safeguard data that are in an electronic format:

(No Answer Given)

E Check all of the following that apply for safeguarding tangible materials:

(No Answer Given)

F With whom, outside the immediate research team, will identifiable data be shared? Upload data use agreements, if any.

(No Answer Given)

G Describe the plans for disposition of data that are identifiable in any way (directly or via indirect codes) once the study has ended. When will the materials be destroyed? How and when will identifiers, if any, be destroyed? If it is not possible to destroy the identifiers, provide a scientific, legal, or health justification.

Figure 89: IRB Application Page 8/18

(No Answer Given)

Investigational Medical Device Studies

A The Principal Investigator must provide the Institutional Review Board with his/her risk determination; that is, the PI must state whether he/she believes the investigational device poses Significant Risk or Nonsignificant Risk for subjects. The assertion of Significant Risk or Nonsignificant Risk must be adequately supported with suitable documentation, such as a written description of a comparison device and other study data. If the Principal Investigator has obtained a risk determination letter from the Food and Drug Administration (FDA), that letter must be uploaded here. Indicate your risk determination and provide the justification below.

*****BEFORE COMPLETING THE REST OF THIS SECTION, CONTACT THE OFFICE OF RESEARCH INTEGRITY ASSURANCE IF YOU BELIEVE THAT THE DEVICE POSES SIGNIFICANT RISK. *****

(No Answer Given)

B In addition to the Food and Drug Administration's Risk Determination, upload all other correspondence with the FDA.

(No Answer Given)

C What is the name of the device?

(No Answer Given)

D Select the appropriate check boxes below that describe the investigational medical device. Click all that apply.

(No Answer Given)

E What is the specific, intended use of the investigational medical device? What disease, disorder, or condition, if any, is this investigational medical device intended to cure, mitigate, treat, or prevent? How will this proposed use differ from currently available devices?

(No Answer Given)

F Specify the manufacturer of the device, including name, address, contact person, and telephone number.

(No Answer Given)

G Describe the methods, facilities and controls used for the manufacture of the device, including plans for packing, storage and, if applicable, installation.

Figure 90: IRB Application Page 9/18

(No Answer Given)

H List the device components, ingredients, and properties.

(No Answer Given)

I Provide complete instructions for use of the Investigational Medical Device.

(No Answer Given)

J List the principles of operation.

(No Answer Given)

K Discuss bench testing regarding safety of the device. Any safety and sterilization certification letters should be uploaded, and compliance with ISO standards should be discussed.

(No Answer Given)

L Provide the device label language. The general labeling requirements for medical devices are contained in 21 CFR Part 801 and 812.

(No Answer Given)

M Report relevant prior clinical, animal and laboratory testing of the device. This report must include the following:

A bibliography of all publications, whether adverse or supportive, that are relevant to an evaluation of the safety and effectiveness of the device
Copies of all published and unpublished adverse information
A summary of all other unpublished information (whether adverse or supportive) that is relevant to an evaluation of the safety and effectiveness of the device
If nonclinical laboratory data are provided, a statement that such studies have been conducted in compliance with the Good Laboratory Practice (GLP) regulation in 21 CFR Part 58.
If the study was not conducted in compliance with the GLP regulation, include a brief statement of the reason for noncompliance.

(No Answer Given)

N The Food & Drug Administration assigns devices to one of three regulatory classes based on the level of control necessary to assure the safety and effectiveness of the device.

Specify the FDA Device Class and Regulatory Controls applicable to this device by checking one of the three classes (and corresponding requirements) below:

(No Answer Given)

O If the Food and Drug Administration has issued an Investigational Device Exemption Number, provide it here.

Figure 91: IRB Application Page 10/18

(No Answer Given)

P If any components, parts, ingredients, or other materials comprising this device will be imported, state the source of export including name of entity and full address for each component, part, ingredient, or other material.

(No Answer Given)

Q If the device will be exported for any purpose during this study, identify the person and address to whom it will be exported, and explain why the export will occur.

(No Answer Given)

R If this study is investigator-initiated, the Principal Investigator is considered the Sponsor of the study. Describe how the Principal Investigator will satisfy the considerable additional FDA responsibilities associated with serving as Sponsor.

(No Answer Given)

S Describe the procedures for monitoring the investigation at all study sites.

(No Answer Given)

T What safeguards are in place to ensure that the investigational device will only be used as described in the protocol?

(No Answer Given)

Investigational New Drug Studies

A Specify the clinical entity where the research will take place and provide the names of research collaborators at that location.

(No Answer Given)

B State the drug name, including brand and generic names.

(No Answer Given)

C Provide the Investigational New Drug (IND) Number, if any, assigned by FDA.

(No Answer Given)

D Provide the drug manufacturer name, and include address and telephone number.

(No Answer Given)

E Indicate how the investigational drug will be evaluated in this study, whether being used off

Figure 92: IRB Application Page 11/18

label, in accordance with current FDA approval, or as an investigational new mode. Include mode of administration.

(No Answer Given)

F For each drug that is to be administered, upload a copy of the packet insert and Federal Form 1572 in the ATTACH DOCUMENTS section of the application. If these are not available, explain why.

(No Answer Given)

Multi Site Studies

A Is Georgia Tech the lead site of a multi site study? If yes, provide a list of the sites and contact information.

(No Answer Given)

B If Georgia Tech is participating in a multi-site study, but is NOT the lead institution, specify the lead institution and upload the following documentation from that institution in the ATTACH DOCUMENTS section at the end of this online application.

IRB approval letter
IRB approved consent form
IRB approved protocol
IRB approved recruitment materials
IRB approved Authorization to Use and Disclose Protected Health Information, if applicable

(No Answer Given)

Studies Taking Place in International Locations

A Specify the country or countries outside of the United States where this proposed work will take place. Include names of cities, villages, and other locations.

(No Answer Given)

B Was the researcher invited into the community? If yes, state by whom or what entity, and provide documentation for the collaboration. Include contact information for the local sponsor/entity.

If the researcher was not invited into the community, describe how the researcher will have culturally appropriate access to the community in order to conduct the study.

(No Answer Given)

Figure 93: IRB Application Page 12/18

C If the host country has an ethics committee or other regulatory entity (IRB equivalent), the researcher must obtain its approval prior to starting research in-country. Provide the name and contact information for that entity, and upload here a copy of the letter of approval. If the letter is not written in English, also upload a certified English translation.

The Georgia Tech IRB recognizes that some research sites will have no local review committee or process. In some cases, tribal/village chiefs will provide verbal permission for the study to be conducted, or the approval process will be rather casual. In such cases, describe below how that approval has been obtained.

Researchers may also consult the international research resouces provided by the federal Office for Human Research Protections, linked from www.researchintegrity.gatech.edu. Click on INSTITUTIONAL REVIEW BOARD, then on OTHER RESOURCES.

(No Answer Given)

D Describe how cultural norms or local laws differ from U.S. culture with respect to research autonomy of individuals or groups, consent procedures, recruitment techniques, age of majority, whether parental permission is required, etc. Include an explanation of what cultural sensitivities will be required to conduct this study.

(No Answer Given)

E Describe any aspects of the cultural, political, or economic climate that might increase the risks for participants. For instance, certain diseases are particularly stigmatizing in some cultures, or political circumstances might hamper the ability of citizens to speak openly. If such conditions exist in this study location, describe the steps that will be taken to minimize these risks to subjects.

(No Answer Given)

F What is the native language of potential subjects? Describe the ability of researchers to speak, read or write their language. If appropriate, explain provisions for translators.

(No Answer Given)

G If the researcher is a student, describe how the student will communicate with the advisor during the conduct of the research. Add how the advisor will oversee the research.

(No Answer Given)

Studies Involving Prisoners As Subjects

A How will you ensure that any possible advantages accruing to the prisoner through his or her participation in the research, when compared to the general living conditions, medical care,

Figure 94: IRB Application Page 13/18

quality of food, amenities and opportunity for earnings in the prison, are not of such a magnitude that his or her ability to weigh the risks of the research against the value of such advantages in the limited choice environment of the prison is impaired?

(No Answer Given)

B How will you ensure that procedures for the selection of subjects within the prison are fair to all prisoners and immune from arbitrary intervention by prison authorities or prisoners?

(No Answer Given)

C How do you know that parole boards will not take into account a prisoner's participation in the research in making decisions regarding parole, and that each prisoner is clearly informed in advance that participation in the research will have no effect on his or her parole?

(No Answer Given)

D Control subjects must be selected randomly from the group of available prisoners who meet the characteristics needed for that particular research project. If you propose other procedures for selecting controls, describe those proposed procedures and provide justification.

(No Answer Given)

E If there will be a need for follow-up examination or care of prisoner participants after the end of their participation, describe the provisions made for such examination or care, taking into account the varying lengths of individual prisoners' sentences, and for informing participants of this fact.

(No Answer Given)

Studies involving Department of Defense, Radiation, or Nanotechnology

A Does this research activity involve the collection of biological specimens?

No

B If prospective, please specify below:

N/A

C Will specimens be collected anonymously (no way to link sample with subject identity) or in an identifiable (i.e. coded) manner?

Identifiable

D Is genetic testing of these specimens proposed?

No

Figure 95: IRB Application Page 14/18

E Is export control review required? If yes, please go to http://www.export.gatech.edu/

No

F If research involves the use of biological specimens, has Institutional Biological Materials Safeguards Committee approval been obtained? For guidance, please consult the Office of Environmental Health & Safety at 404 / 894-6119.

N/A

G Is use of rDNA proposed? If yes, attach the Institutional Biosafety Committee letter of approval in the Document Upload section of this IRB application. If Institutional Biosafety Committee approval has not yet been secured, submit the IBC application, located at http://www.compliance.gatech.edu/IBC/documents/IBC_REGISTRATION.doc

N/A

H All supporting documentation for this application must be uploaded in IRBWISE. Documents may be uploaded in section VI below called 'Attach Documents'. Please indicate all of the following documents to be uploaded.

Surveys/Questionnaires

Keywords:

Keywords

transit, mapping, bus, information, mode choice

Informed Consent Procedures:

Name	Description	Approval Date
Waiver of Documentation	Per 45CFR46.117(c) an IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects if it finds either: (1) That the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Each subject will be asked whether the subject wants documentation linking the subject with the research, and the subject's wishes will govern; or (2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context	April

Figure 96: IRB Application Page 15/18

of Consent		13, 2012
	****Please note that this option requires a consent document without the signature section: In cases where the requirement of documentation is waived (e.g., use of an anonymous survey is proposed, telephone survey, or web-based survey), a consent document in Georgia Institute of Technology IRB-required format must still be used. However, the document is written in letter format (Dear Subject) and, rather than requiring subject signature to verify consent, the following text is used to end the letter: If you _____ (e.g., complete the attached survey, answer these few questions etc.), it means that you have read -- or have had read to you -- the information contained in this letter and would like to be a volunteer in this research study. Thank you, (Signatures of Investigators) Per 45CFR46.116 (d) an IRB may approve a consent procedure which does not include, or which alters, some or all of the elements of informed consent set forth in this section, or waive the requirements to obtain informed consent provided the IRB finds and documents that:	
Waiver of Consent*	(1) the research involves no more than minimal risk to the subjects; (2) the waiver or alteration will not adversely affect the rights and welfare of the subjects; (3) the research could not practicably be carried out without the waiver or alteration; and (4) whenever appropriate, the subjects will be provided with additional pertinent information after participation.	April 13, 2012

* These Consent Procedures were not requested by an investigator, but were added by an IRB administrator.

Informed Consent

A Type of consent to be obtained:

Waiver of documentation of consent. Please explain below. (Specific criteria must be met--THIS SHOULD BE REQUESTED FOR EXAMPLE IN THE CASE OF A WEB-BASED CONSENT FORM OR IF OBTAINING ORAL CONSENT. PLEASE NOTE: A WAIVER OF DOCUMENTATION OF CONSENT DOES NOT MEAN THAT YOU ARE NOT OBTAINING CONSENT YOU ARE JUST NOT OBTAINING A SIGNED CONSENT FORM. IF YOU REQUEST A "WAIVER OF DOCUMENTATION OF CONSENT" YOU MUST STILL SUBMIT THE CONSENT FORM.

There are two parts to this survey. The on-board survey part will ask for oral consent and the mail-home/internet survey which will ask for consent via a checked box.

B Does this research involve a web-based consent/survey? If so, describe the security measures taken to ensure confidentiality.

Yes, please list below:

Figure 97: IRB Application Page 16/18

To ensure confidentiality for the web-based survey, multiple measures will be taken.
For those participating in the mail-home survey, each household will be given the opportunity to complete the survey online. If they choose to do so, they will only provide their unique identifier when filling out the survey, not name or address. Additionally, the survey questions will not ask anything that will make their household identifiable.

C How and where will participants' permission be recorded? You might, for example, state that participants' signatures will be collected on the consent form during a discussion prior to the first experiment.

There are two parts to this survey. The first is an on-board survey on MARTA trains. Participants here will be asked orally for consent and handed a sheet of paper that discusses the project and explains that by completing the survey they agree to be a participant and understand the study and the impact of their input as well as the fact that this is a minimum risk survey. The second part of the survey is a mail-home survey where households will have the choice of completing the paper survey and returning it via mail or they can complete it online via a link provided in the survey. In both the mail home and online modes of conducting the survey, participants will be asked to check a box showing that they agree to be a participant and understand that there is minimum risk involved. The waiver of consent is requested so that the unique identifier is the only thing connecting the households with the targeted marketing data.

D If subjects are unable to give consent (e.g., children or mentally incompetent), describe how and by whom permission will be granted.

Children are excluded from this study and will not be asked to participate.

E Is deception involved in this research? If so, please read the following and then provide your justification in the space below. By its very nature, deception in research violates the principles of voluntary and informed consent to participate in research. Therefore, deception is an extraordinary measure that is not normally permitted in human subjects research. When proposed, the deception must meet all the following criteria: Risks to subjects are no greater than minimal; the rights and welfare of subjects must not be adversely affected; deception is essential in order for the investigator to carry out the research and, at the earliest possible time, subjects must be informed of the nature of the deception, and given a reasonable opportunity to withdraw from participation and to have their data excluded. Other important issues to be considered when using deception are: A reasonable person would be willing to participate in the research if he or she knew the nature and procedures of the study. Any data collected during the deception may be used only with a subject's explicit approval, obtained after the subject has received full disclosure regarding the study. The proposed research is sound in theory and methodology. Anticipated findings will contribute significantly to the general body of knowledge. Vulnerable subjects (the cognitively impaired, children, or prisoners) are excluded from research involving deception. Provide justification for planned deception below.

No

Documents:

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Document Title	Document Type	File Submission Date	Document Approval Date
MARTA Transit Mapping Mail Home Survey (download)	Survey Instrument	March 13, 2012	April 13, 2012
MARTA Transit Mapping On-Board Survey (download)	Survey Instrument	March 13, 2012	April 13, 2012
MARTA Transit Mapping Risk/Benefit Summary (download)	Risk/Benefit Statement	March 13, 2012	April 13, 2012
MARTA Transit Mapping Survey Postcard Reminder (download)	Survey Instrument	March 13, 2012	April 13, 2012
MARTA Transit Mapping Abstract (download)	Abstract	March 14, 2012	April 13, 2012
MARTA Transit Mapping Scientific Methodology (download)	Scientific Methodology	March 14, 2012	April 13, 2012
MARTA Transit Mapping Confidentiality Statement (download)	Confidentiality Statement	March 15, 2012	April 13, 2012
MARTA Transit Mapping Pre-Survey Letter (download)	Survey Instrument	March 16, 2012	April 13, 2012
MARTA Transit Mapping Survey Letter (download)	Survey Instrument	April 9, 2012	April 13, 2012
Proposal to grant source (download)	other	April 9, 2012	April 13, 2012

Total count: 10

Documents Uploaded as Answers to Questions:

note: Use link in question column to view full question and answer text.

Question Group	Question (Limited to 50 Characters)	Answer (Limited to 50 Characters)	Uploaded File	Document Upload Date

None

Supplemental Documents:

File Name	Submitted Date	Submitted By

None

Conflict of Interest

A Does any participating member, staff, students (or his/her spouse or dependant Students and employees) have any financial interest such as royalty, equity or any other payments (e.g. consulting, salary, etc...) in the sponsor or other entities having a financial interest in intellectual property, product, or service which is the subject of the proposed research?

Figure 99: IRB Application Page 18/18

APPENDIX C

POPULAR DESTINATIONS SELECTION

The following seven pages list the final list of all Atlanta attractions. From here, they were narrowed down and only included in a bus rotue that met the required criteria provided service to that location.

Nearest Station	Distance on foot (in miles)	Attraction	Category
Airport	0.1	Hartsfield-Jackson International Airport	Alternate Transportation Mode
Arts Center	0.9	The Millennium Gate	Museum
Arts Center	2	The Museum of Contemporary Art of Georgia (MOCA - GA)	Museum
Arts Center	1	Monarch Tower	Employment Center
Arts Center	0.4	The Proscenium	Employment Center
Arts Center	0.4	Center for Puppetry Arts	Arts/Entertainment
Arts Center	0.8	Twelve Atlantic Station Hotel	Hotel
Arts Center	0.4	100 Colony Square	Employment Center
Arts Center	0.4	400 Colony Square	Employment Center
Arts Center	0.4	Two Midtown Plaza	Employment Center
Arts Center	0.4	International Museum of Arts & Design	Museum
Arts Center	2	The Atlanta Opera	Arts/Entertainment
Arts Center	0.6	201 17th St. Building	Employment Center
Arts Center	0.7	Wachovia Building	Employment Center
Arts Center	0.5	W Atlanta-Midtown	Hotel
Arts Center	0.7	BB&T Building	Employment Center
Arts Center	0.5	Rhodes Hall	Historical Site
Arts Center	0.4	Four Seasons Hotel	Hotel
Arts Center	0.3	The Peachtree	Employment Center
Arts Center	0.5	The Campanile	Employment Center
Arts Center	0.6	Two Peachtree Pointe	Employment Center
Arts Center	0.2	Atlanta Ballet	Arts/Entertainment
Arts Center	0.7	SCAD-Savannah College	Higher Education
Arts Center	0.3	Alliance Theater	Arts/Entertainment
Arts Center	0.9	Amtrak	Other Transportation
Arts Center	0.3	Atlanta Symphony Orchestra	Arts/Entertainment
Arts Center	0.9	Atlantic Station	Shopping Center
Arts Center	0.3	Promenade II	Employment Center
Arts Center	0.4	Symphony Center	Employment Center
Arts Center	0.2	Norfolk Southern	Employment Center
Arts Center	0.4	14th Street Playhouse	Arts/Entertainment
Arts Center	0.2	Earthlink Theater	Arts/Entertainment
Arts Center	0.4	Marriott Suites	Hotel
Arts Center	0.2	Atlantic Center Plaza	Employment Center
Arts Center	0.1	One Atlantic Center	Employment Center
Arts Center	0.3	Woodruff Memorial Arts Center	Arts/Entertainment
Arts Center	0.6	Peachtree Ansley Building - Ansley Park Playhouse	Arts/Entertainment

Table 81: Final Attractions List 1/7

Nearest Station	Distance on foot (in miles)	Attraction	Category
Arts Center	0.8	Botanical Gardens	Tourist Attraction
Ashby	1.3	Paschal's Hotel and Restaurant	Hotel
Ashby	1.3	Bronner Brothers	Other
Avondale	1.2	DeKalb Farmers Market	Groceries/Food
Bankhead	0.2	Maddox Park	Park
Brookhaven/Oglethorpe	1.3	Oglethorpe University	Higher Education
Brookhaven/Oglethorpe	0.2	Brookhaven Plaza	Shopping Center
Brookhaven/Oglethorpe	0.1	Brookhaven Station Shopping Center	Shopping Center
Brookhaven/Oglethorpe	0.06 (341 ft)	Piedmont Health Care - Piedmont Physicians Group	Medical Building
Buckhead	7.5	Cobb Energy Performing Arts Centre	Arts/Entertainment
Buckhead	0.2	Intercontinental Hotel Atlanta	Hotel
Buckhead	0.9	Buckhead Theatre	Arts/Entertainment
Buckhead	0.1	The Mansion on Peachtree, A Rosewood Hotel	Hotel
Buckhead	0.3	Monarch Plaza	Employment Center
Buckhead	1.1	The St. Regis Atlanta	Hotel
Buckhead	0.4	The Pinnacle	Employment Center
Buckhead	0.2	Westin Buckhead	Hotel
Buckhead	0.2	The Lenox Building	Employment Center
Buckhead	1.5	Atlanta History Center	Museum
Buckhead	0.04 (194 ft)	One Capitol City Plaza	Employment Center
Buckhead	0.3	Grand Hyatt Atlanta	Hotel
Buckhead	0.1	Courtyard by Marriott Atlanta Buckhead	Hotel
Buckhead	0.6	Two Alliance Center	Employment Center
Buckhead	0.6	Phillips Tower	Employment Center
Buckhead	0.7	The Prominence	Employment Center
Buckhead	1	Piedmont 14	Employment Center
Buckhead	1.1	Piedmont 15	Employment Center
Buckhead	0.2	Embassy Suites Hotel Buckhead	Hotel
Buckhead	0.6	Atlanta Financial Center	Employment Center
Buckhead	1	One Buckhead Plaza	Employment Center
Buckhead	0.4	Terminus 100	Employment Center
Buckhead	0.4	Terminus 200	Employment Center
Buckhead	3.1	Chastain Memorial Park	Park
Buckhead	0.7	One Securities Center	Employment Center
Buckhead	0.6	Phipps Plaza Mall	Shopping Center
Buckhead	0.3	Ritz Carlton Hotel	Hotel

Table 82: Final Attractions List 2/7

Nearest Station	Distance on foot (in miles)	Attraction	Category
Buckhead	0.3	Tower Place Plaza	Employment Center
Chamblee	1.4	Peachtree DeKalb Airport	Alternate Transportation Mode
Civic Center	0.2	Emory University Hospital Midtown	Medical Building
Civic Center	0.2	Southern Company	Employment Center
Civic Center	0.2	30 Allen Plaza	Employment Center
Civic Center	0.3	55 Allen Plaza	Employment Center
Civic Center	0.2	Peachtree Summit #1	Employment Center
Civic Center	0.5	Civic Center Auditorium	Arts/Entertainment
College Park	1.9	Renaissance Concorse Atlanta Airport Hotel	Hotel
College Park	0.3	College Park City Hall	Government
Decatur	2.3	Emory University	Higher Education
Decatur	2.7	Micale C. Carlos Museum at Emory University	Museum
Decatur	0.2	Decatur Square	Shopping Center
Decatur	4.9	South DeKalb Mall	Shopping Center
Dome/GWCC/Phillips/CNN	0.3	CNN Center	Employment Center
Dome/GWCC/Phillips/CNN	0.6	Georgia Aquarium	Tourist Attraction
Dome/GWCC/Phillips/CNN	0.5	Hilton Garden Inn Atlanta Downtown Hotel	Hotel
Dome/GWCC/Phillips/CNN	0.2	Omni Tower at CNN Center	Hotel
Dome/GWCC/Phillips/CNN	0.2	Georgia Dome	Sport Arena
Dome/GWCC/Phillips/CNN	0.5	City Segway Tours	Tourist Attraction
Dome/GWCC/Phillips/CNN	0.6	New World of Coca-Cola	Tourist Attraction
Dome/GWCC/Phillips/CNN	0.05 (282 ft)	Philips Arena	Sport Arena
Doraville	0.01	Doraville City Hall	Government
Doraville	0.007 (36 ft)	Doraville County Health Center	Medical Building
Dunwoody	0.3	Perimeter Mall	Shopping Center
East Lake	1.2	Fernbank Museum Science Center	Museum/Arts
East Lake	1.5	Fernbank Museum of Natural History	Museum/Arts
East Lake	1.9	Charlie Yates Golf Course	Other
East Lake	2.1	East Lake Golf Club	Other
East Point	3.6	Greenbriar Mall	Shopping Center
East Point	0.4	East Point City Hall	Government
Edgewood/Candler Park	2	Callanwolde Arts Center	Arts/Entertainment
Five Points	0.1	Heritage Row	Historical Site
Five Points	0.3	Georgia State University	Higher Education
Five Points	0.2	W.D. Grant Building	Employment Center

Table 83: Final Attractions List 3/7

Nearest Station	Distance on foot (in miles)	Attraction	Category
Five Points	0.05 (259 ft)	Comfort Suites Downtown Convention Center	Hotel
Five Points	0.3	Centennial Tower	Employment Center
Five Points	0.09 (459 ft)	Sam Nunn Atlanta Federal Center	Government
Five Points	0.1	James H. Floyd Towers	Employment Center
Five Points	0.2	55 Marietta Street Building	Employment Center
Five Points	0.3	Hurt Building	Employment Center
Five Points	0.2	Five Points Plaza	Employment Center
Five Points	0.2	Fulton County Probate Court	Government
Five Points	0.3	260 Peachtree Building	Employment Center
Five Points	0.3	Russell Federal Building	Employment Center
Five Points	0.5	Oakland City Flea Market	Shopping Center
Five Points	0.2	State of Georgia Building	Employment Center
Five Points	0.2	One Park Tower	Employment Center
Five Points	0.2	Commerce Building	Employment Center
Five Points	1.8	Cyclorama	Historical Site
Five Points	1.3	Martin Luther King Center	Museum
Five Points	0.1	Atlanta - Cruzers Electric Car City Tours	Tourist Attraction
Five Points	0.2	Underground Atlanta	Shopping Center
Five Points	1.8	Zoo Atlanta	Tourist Attraction
Five Points	0.3	Richard B. Russell Building	Government
Garnett	0.3	City Hall	Government
Georgia State	0.2	Grady Memorial Hospital	Medical Building
Georgia State	0.7	Centennial Olympic Cauldron	Tourist Attraction
Georgia State	0.6	Holiday Inn Select Atlanta Capitol Conference Center	Hotel
Georgia State	0.5	Robert W. Woodruff Volunteer	Employment Center
Georgia State	0.3	Georgia Capitol	Government
Georgia State	0.2	Fulton County Health Services - Aldredge	Medical Building
Georgia State	0.7	Archives Bulding	Government
Georgia State	1.2	Turner Field	Sport Arena
Hamilton E. Holmes	5.4	Greenbriar Mall	Shopping Center
Hamilton E. Holmes	6.5	Six Flags Over Georgia	Tourist Attraction
Indian Creek	6	Stone Mountain Park	Park
Inman Park/Reynoldstown	0.6	7 Stages	Arts/Entertainment
Inman Park/Reynoldstown	1.5	East Atlanta Village	Shopping Center
Inman Park/Reynoldstown	0.6	Dad's Garage Theatre	Arts/Entertainment
Inman Park/Reynoldstown	0.6	Horizon Theatre Company	Arts/Entertainment

Table 84: Final Attractions List 4/7

Nearest Station	Distance on foot (in miles)	Attraction	Category
Inman Park/Reynoldstown	0.8	Little Five Points Shopping Center	Shopping Center
Kensington	0.3	Kensington Office Park	Employment Center
King Memorial	1.4	Grant Park	Park
King Memorial	1.1	Cabbagetown	Historical Site
King Memorial	0.3	Oakland Cemetary	Historical Site
King Memorial	0.7	Martin Luther King Jr Recreation Center	Recreation Center
Lakewood/Ft. McPherson	3.4	Aarons Amphitheatre at Lakewood	Arts/Entertainment
Lenox	0.2	Atlanta Plaza One	Employment Center
Lenox	0.6	Lenox Towers	Employment Center
Lenox	0.2	Resurgens Plaza	Employment Center
Lenox	0.4	JW Marriott Atlanta Buckhead	Hotel
Lenox	0.6	Lenox Square Mall	Shopping Center
Lindbergh	14.8	Whitewater Park	Park
Lindbergh	0.04 (220 ft)	AT&T Lindberg West/East	Employment Center
Lindbergh	18.5	Kennesaw Mountain National Battlefield and Museum	Historical Site
Lindbergh	0.2	Lindbergh Plaza	Shopping Center
Lindbergh	0.3	U.S. Post Office	Government
Medical Center	0.4	Northside Hospital	Medical Building
Medical Center	0.4	Scottish Rite Hospital	Medical Building
Medical Center	0.2	St. Joseph's hospital	Medical Building
Midtown	0.3	Midtown Hotel	Hotel
Midtown	0.2	Margaret Mitchell House	Historical Site
Midtown	0.4	Midtown One Office Tower	Employment Center
Midtown	0.4	1100 Peachtree Building	Employment Center
Midtown	0.2	Wachovia Plaza	Employment Center
Midtown	0.4	RBC Centura Bank	Employment Center
Midtown	0.05 (266 ft)	Ten Peachtree Place	Employment Center
Midtown	0.1	Millennium in Midtown	Employment Center
Midtown	0.2	Atlanta Marriott Buckhead Hotel & Conference Center	Hotel
Midtown	2	Virginia Highlands	Shopping Center
Midtown	0.2	Renaissance Atlanta Midtown Hotel	Hotel
Midtown	0.8	Alexander Memorial Coliseum	Sport Arena
Midtown	0.2	Residence Inn Atlanta Midtown/Historic	Hotel
Midtown	0.09 (482 ft)	Regency Suites Hotel	Hotel

Table 85: Final Attractions List 5/7

Nearest Station	Distance on foot (in miles)	Attraction	Category
Midtown	0.7	Piedmont Park	Park
Midtown	0.2	Federal Reserve Bank of Atlanta	Government
North Avenue	0.6	Coca-Cola Headquarters	Employment Center
North Avenue	0.4	Georgia Tech	Higher Education
North Avenue	1.3	Atlanta Contemporary Art Center	Arts/Entertainment
North Avenue	0.5	Hampton Inn-Georgia Tech	Hotel
North Avenue	0.1	The Varsity	Restaurant
North Avenue	0.2	Fabulous Fox Theater	Arts/Entertainment
North Avenue	0.2	Georgian Terrace	Hotel
North Avenue	0.2	Bank of America Plaza	Employment Center
North Avenue	0.07 (354 ft)	One Georgia Center	Employment Center
North Avenue	0.07 (344 ft)	AT&T Midtown Center	Employment Center
North Avenue	0.1	Mielia Hotel Atlanta	Hotel
North Springs	0.07 (371 ft)	North Springs Station North Parking Garage	Alternate Transportation Mode
North Springs	0.2	North Springs Station South Parking Garage	Alternate Transportation Mode
Peachtree Center	0.2	Robert W. Woodruff Park	Park
Peachtree Center	0.4	Centennial Olympic Park	Park
Peachtree Center	0.1	Peachtree Center International Tower	Employment Center
Peachtree Center	0.3	Inforum	Employment Center
Peachtree Center	0.2	Equitable Building	Employment Center
Peachtree Center	0.2	55 Park Place Building	Employment Center
Peachtree Center	0.5	Atlanta Center Building	Employment Center
Peachtree Center	0.1	Peachtree Center North	Employment Center
Peachtree Center	0.1	Peachtree Center South	Employment Center
Peachtree Center	0.3	AT&T Communications Building	Employment Center
Peachtree Center	0.3	Marquis I	Employment Center
Peachtree Center	0.3	Marquis II	Employment Center
Peachtree Center	0.2	Trust Company of Georgia Building	Employment Center
Peachtree Center	0.3	Tabernacle	Arts/Entertainment
Peachtree Center	0.06 (308 ft)	Sun Dial Resturant Bar & View	Resturant
Peachtree Center	0.2	Agatha's - A Taste of Mystery	Arts/Entertainment
Peachtree Center	0.2	Peachtree Center Tower	Employment Center
Peachtree Center	0.03 (154 ft)	The Ellis Hotel	Hotel
Peachtree Center	0.3	SunTrust Plaza	Employment Center
Peachtree Center	0.1	Mall at Peachtree Center	Shopping Center

Table 86: Final Attractions List 6/7

Nearest Station	Distance on foot (in miles)	Attraction	Category
Peachtree Center	0.3	Atlanta Fulton Public Library System	Government
Peachtree Center	0.1	AmericasMart	Retail
Peachtree Center	0.2	Harris Tower	Employment Center
Peachtree Center	0.3	Planet Hollywood	Restaurant
Peachtree Center	0.5	Children's Museum of Atlanta	Museum
Peachtree Center	0.6	Georgia Pacific Tower	Employment Center
Peachtree Center	0.02 (118 ft)	Ritz Carlton	Hotel
Peachtree Center	0.3	Marriott Marquis	Hotel
Peachtree Center	0.05 (243 ft)	Westin Peachtree Plaza	Hotel
Peachtree Center	0.4	Hilton Atlanta Hotel	Hotel
Peachtree Center	0.2	Hyatt Regency	Hotel
Peachtree Center	0.3	Days Inn Atlanta Downtown	Hotel
Peachtree Center	0.06 (338 ft)	191 Peachtree Tower	Employment Center
Peachtree Center	0.1	Candler Building	Employment Center
Sandy Springs	0.3	Perimeter Pointe Shop Plaza	Shopping Center
Sandy Springs	0.2	Northpark Towncenter	Mixed Use
Sandy Springs	0.4	The Art Institute of Atlanta	Higher Education
Sandy Springs	0.3	Embassy Suites	Hotel
Vine City	0.4	Georgia World Congress Center	Convention Center
Vine City	0.5	Fulton county Health Center	Medical Building
Vine City	0.4	Morris Brown College	Higher Education
Vine City	0.3	Alonzo F. Herndon Olympic Stadium	Entertainment
Vine City	0.9	Clark Atlanta University	Higher Education
Vine City	1.1	Spelman College	Higher Education
Vine City	1.3	Morehouse College	Higher Education
West End	0.5	West End Shopping District	Shopping Center
West End	0.7	Wren's Nest (Joel Chandler Harris)	Museum
West End	0.5	Post Office	Government
West Lake	0.5	Westview Cemetary	Historical Site

Table 87: Final Attractions List 7/7

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